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Vol. CXXXII.—No. 3442] LONDON: FRIDAY EVENING, DECEMBER 16, 1921 [Price One Shilling By Inland Post 1s. 5d.

PUBLIC NOTICES

Civil Engineer for Railway Construction REQUIRED by the GOVERNMENT of NIGERIA for two tours, each of 12 to 18 months' service, with possible extension. Initial salary £480 to £600 a year, according to qualifications, rising by annual increments of £30. Commuted allowance of £12 a month, payable in lieu of quarters. Outfit allowance of £60 payable on first appointment. Free first-class passages. Liberal leave in England on full salary.

Candidates, preferably single, aged 25 to 35, must be fully qualified civil engineers, who have had practical experience on Railway Survey and Construction.—Apply at once, in writing, stating age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/Nigeria 11,264. 6914

Civil Engineer Required by the GOVERNMENT of HONG KONG for three years' service as an ASSISTANT ENGINEER in the PUBLIC WORKS DEPARTMENT, with prospect of permanency. Salary £480 a year, rising by annual increments of £20 to £600 per annum, with temporary addition of exchange allowance. Free passages provided.

Candidates, unmarried, age 25 to 30 years of age, must be A.M. Inst. C.E., and have had experience on the construction of waterworks and in the use of concrete. Preference will be given to candidates who have been trained in a waterworks engineer's office.—Apply at once, in writing, giving age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/Hong Kong 11,912. 6948

Civil Engineer Required by the GOVERNMENT of CEYLON for two years' service as an ASSISTANT ENGINEER on the HARBOUR WORKS, COLOMBO, with prospect of permanency. Salary £700 per annum plus a temporary increase of 25 per cent. (not to exceed £150 per annum), and a station allowance of 7½ per cent. of salary if unmarried and 11 per cent. if married. Quarters not provided. Free passages.

Candidates, preferably single, must have had extensive experience in Harbour and Dock Construction, Dredging, &c., and possess organising and administrative abilities.—Apply at once, in writing, giving age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/Ceylon 11,345. 6950

Colonial Engineer Required by the GOVERNMENT of ST. VINCENT, BRITISH WEST INDIES, for three years' service, with prospect of permanent and pensionable employment. Salary £350 per annum, with a travelling allowance of £60 per annum. Free passages. Good climate and moderate cost of living. Quarters not provided.

Candidates, preferably single, must be civil engineers and surveyors, trained and experienced in the construction of Roads, Culverts, Small Bridges, Public Buildings, Jetties, &c., and must possess a working knowledge of telephone instruments, switchboards, and lines.

Apply at once, in writing, stating age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/St. Vincent 11,007. 6932

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of WROUGHT IRON PIPES.

Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 3rd January, 1922.

6954 T. RYAN.

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of BORING MACHINES.

Forms of Tender may be obtained from the Director General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 3rd January, 1922.

T. RYAN,
6927 Director-General.

Imperial College of Science and Technology.

There is a VACANCY in a DEMONSTRATORSHIP in the Department of Mathematics and Mechanics in the Royal College of Science, South Kensington, S.W. 7. The appointment will be made as from the beginning of January, 1922, under the College conditions attaching to the office of Demonstrator, and the stipend will be at the rate of £300 per annum. The Demonstrator will have to take part in the teaching of Mathematics and Mechanics, and it is desirable that he should have had workshop and drawing-office experience.

Applications should be addressed to PROFESSOR A. R. FORSYTH, F.R.S., at the Imperial College. 6981

Metropolitan Water Board.

SUPPLY OF APPROX. 1112 FEET OF 48in. DIA. SOCKET AND SPIGOT LAP-WELDED STEEL TUBE IN 16ft. AND 8ft. LENGTHS

The Metropolitan Water Board invite TENDERS for the SUPPLY of 67 16ft. and 5 8ft. Lengths of 48in. dia. SOCKET and SPIGOT LAP-WELDED STEEL TUBE and TWO BENDS, required for various railway and river crossings on the line of the 48in. main, Walton to Honor Oak (Section Nos. 1 and 2). The steel is to be of good ductile quality of British manufacture, made by the open-hearth process, of tensile strength of 24 to 28 tons per square inch, and shall comply in every respect with the British standard specification.

Forms of Tender, conditions of contract, specification and drawings, &c., may be obtained on personal application at the offices of the Board (Room 150), New River Head, 173, Rosebery-avenue, E.C. 1, or upon forwarding a stamped addressed brief envelope.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for 48in. dia. Steel Tubes," must be delivered at the offices of the Board not later than 10 a.m. on 10th January, 1922.

The Board do not bind themselves to accept the lowest or any Tender.

W. MOON,
Clerk of the Board.

Offices of the Board,
New River Head,
173, Rosebery-avenue, E.C. 1,
12th December, 1921. 6949

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Greek and Roman Engineering Instruments.

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A Valveless, Gearless Engine.

Brassey's Annual.

Sorbitic Steel for Railway Tires.

Power from Sewage Gas.

New Worm Gear Generating Machine.

PUBLIC NOTICES

Borough of Beverley.

SEWERAGE WORKS.
CONTRACT No. 1.

The Town Council are prepared to receive TENDERS for the CONSTRUCTION of a SECTION of a NEW OUTFALL SEWER along the Beckside, in the Borough of Beverley.

The sewer to be 21in. diameter in cast iron pipes or alternatively in approved concrete pipes.

Contractors desirous of tendering are requested to send applications either to Mr. J. Gould Smith, A.M.I.C.E., Borough Surveyor, Beverley, or to Mr. William Fairley, M. Inst. C.E., Consulting Engineer Parliament Mansions, Westminster, S.W.

Notice will be sent to selected firms where and when the drawings, specifications, and schedules may be inspected.

Tenderers must be prepared to begin active operations before the 1st January, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

J. DENNETT,
Town Clerk.

7th December, 1921,
Lairgate, Beverley. P4551

West Kent Main Sewerage Board.

EXTENSION OF MAIN OUTFALL WORKS.

TENDERS are INVITED for the CONSTRUCTION of PRECIPITATION and STORAGE TANKS, SEWER, BUILDINGS, and other WORKS at Long Reach, Dartford.

Drawings may be seen at the offices of the Consulting Engineer, Sidney R. Lowcock, M. Inst. C.E., 8, Queen Anne's-gate, Westminster, or at the offices of the Board, and a copy of the conditions of contract, specifications, bill of quantities, form of Tender, &c., may be obtained from the undersigned upon payment of a deposit of Five Pounds, which will be returned upon receipt of a bona fide Tender, not afterwards withdrawn.

Tenders, sealed and endorsed "Contract No. 4," must be delivered to me, at the offices of the Board, on or before Twelve Noon, Saturday, the 31st December next.

The Board do not bind themselves to accept the lowest or any Tender

ARTHUR B. COOMBER,
Secretary.

Offices of the Board,
Park House, Bromley, Kent. 6880

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
ADJUSTABLE SHORES.

The Proprietor of British Letters PATENT No. 102,356 of 1916 is PREPARED to SELL the PATENT or to LICENSE British manufacturers to work thereunder. It relates to adjustable shores for supporting concrete floor forms, &c., during setting of the material, having a pair of relatively movable members and clamping yokes.

Address: D. W. & T.,
111 and 112, Hatton-garden,
6916 London, E.C. 1

The National Foremen's Association of the ENGINEERING AND ALLIED TRADES.
(Registered under the Trade Union Act.)

An Association specially formed to look after the interests of Foremen in their Supervisory Capacity. All communications to Head Offices,

H. W. REID, 85, Belgrave-road,
General Secretary. Victoria, S.W. 1.

PUBLIC NOTICES

Penybont Rural District Council.

PENCOED AND COYCHURCH HIGHER JOINT SEWERAGE AND SEWAGE DISPOSAL WORKS, AND SUBSIDIARY SEWERS FOR PENCOED AND COYCHURCH HIGHER.

CLERK OF WORKS

(To commence duties at an early date).

The Council invite APPLICATIONS for the above APPOINTMENT. Candidates must be thoroughly experienced in the construction of Modern Sewage Disposal and Drainage Works and be able to efficiently discharge the duties required of Clerk of Works on works of this kind, and must be competent with the use of the level and theodolite, and be able to set out and measure up works and keep accounts, &c.

No others need apply.

Preference will be given to ex-Service men.

The Clerk of Works will be required to act under the direction of Major T. J. Moss-Flower, the Council's Consulting Engineer, and devote the whole of his time to the duties of his office.

Salary £7 per week. No out-of-pocket expenses will be paid.

Time, about nine months subject to approved service, and the engagement to be terminable by a fortnight's notice on either side.

Applications, marked "Clerk of Works," stating any previous experience and enclosing copies of three recent testimonials, to be sent direct to the Engineer at his Bristol office, Carlton Chambers, Baldwin-street, Bristol, so as to reach him not later than Noon on Friday, December 23rd, 1921.

E. HARMER COX,
Solicitor and Clerk to the Council.

December 5th, 1921,
Council Offices,
Wyndham-street, Bridgend. 6925

SITUATIONS OPEN

CEMENT WORKS, INDIA.

WANTED, as ASSISTANT GENERAL MANAGER for large Cement Works in India, qualified ENGINEER, with a complete knowledge of the manufacture of Cement (wet process). Three years' agreement, free unfurnished quarters.—Write, giving full particulars of experience and salary required, to Z. C. 345, c/o Deacon's, Leadenhall-street, E.C. 3. 6930 A

WANTED, ASSISTANT to WORKS MANAGER, capable of progressing work through factory; knowledge of machine shop practice, press tool and sheet metal work. Real live man wanted. South London district. State age, experience, and salary expected.—Address, P4547, The Engineer Office. P4547 A

BOILER INSPECTOR REQUIRED for Chinese Government Railways. Candidates should have held similar position with one of the leading British or Colonial railways, and be fully qualified. Appointment on 3 years' agreement at the following salaries: £360, £372, £384 per annum.—Applications, by letter only, stating particulars as to qualifications, age, and physical fitness, together with copies of testimonials, to "E. H.," c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, London, E.C. 6922 A

ENGINEER REQUIRED for Speciality Work and may have to do considerable amount of draughtsman's work. Must have good mathematical and practical knowledge of Hydraulics (including pipe line lay-outs), and good all-round knowledge engineering, including some electrical engineering. Must be used to estimating and capable of dealing with technical correspondence. Will be frequently required to travel. Salary £200-£250. State age.—Address, 6951, The Engineer Office. 6951 A

REQUIRED for Small Engineering Works in South of England, a Fire BUYER; must have good experience and knowledge of markets and be able to keep accounts. Sale experience and salary required.—Address, 6866, The Engineer Office. 6866 A

SITUATIONS OPEN (continued)

PRODUCTION ENGINEER REQUIRED for Engineering works in France. Must be thoroughly experienced in up-to-date production methods, speak and write French; young man under 35 preferred; initial salary £35 to £40. Write fullest particulars, with references, copies testimonials (no incomplete applications considered).—L. G. C., 32, Temple Fortune-lane, London, N.W. 11. P4350 A

REQUIRED by Old-established Firm of Engineers in India, ONE STRUCTURAL and ONE MECHANICAL DRAUGHTSMAN, age about 25. Only single men with a thorough training and good experience need apply.—Reply, fully stating age, experience, and salary required, to Z. Y. 339, c/o Deacon's, Leadenhall-street, London, E.C. 3. 6939 A

SMALL TOOLS AND STEEL.—AGENT REQUIRED, North-East Coast. Liberal commission offered good firm.—Address, 6918, The Engineer Office. 6918 A

THE SERVICES of a GENTLEMAN Trained as an Engineer with good practical experience, chemical or scientific degree and commercial knowledge, are REQUIRED by a manufacturing firm near London: age 30-40.—Address, giving full experience, P4524, The Engineer Office. P4524 A

TRAVELLER REQUIRED, Internal Combustion Engines, Agricultural Machinery, and Machine Tools. Commission basis.—Applications, stating district, to PERCY R. CLARK, 26, Charing Cross-road, London, W.C. P4556 A

LONDON REPRESENTATIVE.

WELL-KNOWN SCOTTISH FIRM, Engineers and Founders, require ENGINEER for LONDON OFFICE. Thorough commercial experience and good connection.—Address, stating experience, qualifications, age, salary expected, 6878, The Engineer Office. 6878 A

WORKS MANAGER, with Ability, REQUIRED for important works with about 1000 employees in normal times, devoted to the production of a high-class engineering specialty. Must have sound experience in controlling staff and be thoroughly conversant with up-to-date machine shop practice for medium and heavy work, including gear cutting of all descriptions. Applicants should be possessed of broad outlook and be capable of obtaining high-class production on the most economical lines. Elaborate systems and expensive organisation undesirable. Applications, in strict confidence, stating salary expected, age, and brief outline of experience. Only first-class men who have made a success in a similar position should apply.

Address, "ENGINEERING," Wm. Porteous and Co., Advertising Agents, Glasgow. P4555 A

WANTED, Thoroughly Skilled DRAUGHTSMAN; one with knowledge of Hydraulic Press Work preferred, capable of taking full charge.—Address full particulars, 6944, The Engineer Office. 6944 A

DESIGNING DRAUGHTSMAN, Engineering Works, experienced in designing and detailing Steel Wagons and all classes of Riveted Work. None but really first-class men with sound experience need apply.—Address, P4549, The Engineer Office. P4549 A

DRAUGHTSMAN WANTED, Used to Steel Works practice, particularly Rolling Mills.—Address, 6947, The Engineer Office. 6947 A

DRAUGHTSMAN, with Experience in Aerial Ropeways and/or Crane Work.—Please state experience and salary required to Chief Draughtsman, JOHN M. HENDERSON and CO., Aberdeen. 6933 A

JUNIOR DRAUGHTSMAN REQUIRED; Able to design and estimate for Light Structural Steel Work and Tanks. London district.—Address, P4548, The Engineer Office. P4548 A

LEADING DRAUGHTSMAN REQUIRED for Turbine design; capable of taking full charge of department and working out general and detailed designs in accordance with latest developments.—Apply by letter, 6920, The Engineer Office, stating experience and salary required. 6920 A

SENIOR DRAUGHTSMAN, Ex-Service (Used to Automobile or similar work) WANTED. Wages, including Civil Service bonus, 104s. 6d. per week.—Apply, in writing, to SUPERINTENDENT, Tank Design and Experiment, Charlton House, Old Charlton, S.E. 7. 6914 A

ASSISTANT or FOREMAN ENGINEER REQUIRED for Brewery Work, with good general experience Steam and Electrical. Must be prepared to live on the premises in London; age 28 to 35.—Address, giving full particulars and stating salary required, P4570, The Engineer Office. P4570 A

CHIEF PIECEWORK RATE FIXER REQUIRED, with experience on machine work and assembly of parts for large and small Electrical Switchgear. Applicants should be men with first-rate shop training and ability to set prices which can be maintained. Previous experience in a similar capacity absolutely essential.—Address, 6871, The Engineer Office. 6871 A

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SITUATIONS WANTED

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT. Services available for New Year or possibly before.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 3. 6926 B

ENGINEER (32), A.M.I.E.E., B.Sc., DESIRES executive POST immediately; highly exper., prac., tech., commercial, with large firms 10 years, home and abroad; structural and maintenance a speciality. Will consider any offers, chief or assistant preferred.—Address, P4484, The Engineer Office. P4484 B

ENGINEER (35), B.Sc., Assoc. M. Inst. C.E., DESIRES POSITION as TECHNICAL ASSISTANT, COMMERCIAL ENGINEER or REPRESENTATIVE. Practical, technical, commercial and sales experience in steam engineering and steel trades. Good linguist. —Address, P4557, The Engineer Office. P4557 B

ENGINEER DESIRES Responsible POSITION; home and foreign experience, erection and testing of modern boilers and power plants complete with buildings, ferro-concrete work, &c. Willing to go anywhere. Excellent references; good French and Spanish.—Address, P4511, The Engineer Office. P4511 B

ENGINEER-SALESMAN, with Five Years' Practical, six years' selling and war-time service as naval engineer afloat, WANTS POSITION on Sales Force, inside or out.—P4565, The Engineer Office. P4565 B

MECHANICAL ENGINEER, 16 Years' Good All-round general experience as foreman, cost clerk and manager, SEEKS RESPONSIBLE POST in any capacity.—SNOAD, 36, York-road, Hitchin. P4567 B

£1250 P.A. and Percentage on Results will secure services of fully qualified ENGINEER; complete commercial experience, organiser and develop new or established business, home and export. Conversant all aspects buying, manufacture, costing, sales, publicity; able, due administrative experience, handle staff and employers.—Address, P4506, The Engineer Office. P4506 B

CHIEF DRAUGHTSMAN.—Competent Technical Engineer will be free to ACCEPT ENGAGEMENT in the new year. Exceptionally wide experience steam, marine, automobile, aeronautical, tool and gauge, rolling mill, chemical works, electrical, hydraulic, masonry, steel and reinforced construction. —Address, P4564, The Engineer Office. P4564 B

FOUNDRY FOREMAN (38), Malleable, Cast Iron, gun-metal, bronze; capable of taking entire control; excellent reference.—Address, P4520, The Engineer Office. P4520 B

MECHANICAL FOREMAN (28), Thoroughly Experienced all branches of manufacture of small machinery; specialist electric lamp making machinery; excellent refs.—Address, P4353, The Engineer Office. P4353 B

SMITHY and FORGE FOREMAN; 12 Years Foreman, marine and general engineering, forging process, heat treatment, fixing piecework prices, technical training, advanced methods, tactful.—Address, P4545, The Engineer Office. P4545 B

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AGENCIES

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MISCELLANEOUS

PATENTS, INVENTIONS, TRADE MARKS DESIGNS. Advice and handbook free.—KING'S PATENT AGENCY, Limited (B. T. King, Director), 146a, Queen Victoria-street, London. 35 years' refs. Tel., Central 682. 6661 I

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MACHINERY, &c., WANTED

WANTED, a NUMBER of Babcock and Wilcox WATER-TUBE BOILERS of medium size for 200 lb. working pressure, to work in pairs; also ONE STEEL CHIMNEY and ECONOMISER for each pair.—Write, "BOILER," c/o Taylor's, 30, Fleet-street, London, E.C. 4. 6838 F

WANTED, New or Equal New Condition, Modern WORM WHEEL HOBBING MACHINE up to 15in. dia.; also WORM GENERATING MACHINE.—Address, 6919, The Engineer Office. 6919 F

WANTED, SECOND-HAND LOCOMOTIVE, Four-wheel coupled, saddle tank, with cylinders 16in. diameter, 4ft. 8½in. gauge. State name of maker, pressure at which boiler is at present insured, and present condition, and say where same may be inspected.—Write, Box P.N., Kidd's Advertising Agency, Middlesbrough. P4562 F

WANTED, TESTING MACHINE, Second-hand, horizontal, to test from 1 to 40 or 100 tons, maximum testing length 60ft., working pressure 1500 lb. per sq. inch. State make and full particulars. —Address, 6943, The Engineer Office. 6943 F

WANTED, 3-Ton STEAM CRANE, 25ft. Jib, Gauge 4ft. 8½in.—Send full particulars to CHARLES JONES and SONS, Ltd., Rhyl. P4568 F

WANTED, 6ft. Treble-geared (Final Gear to be on face-plate) BRAKE LATHE, with bed from 10ft. to 14ft. long, compound slide rest, also heavy slide rest on pillar. State full particulars and send sketch or photograph. Must be heavy, modern tool at a very reasonable price.
THE OXFORD STEAM PLOUGH CO., Ltd., Cowley, Oxon. P4550 F

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15 H.P. CRANE MOTOR, 480 v., 1180 r.p.m., Compound and flexible coupling and non-reversing drum controller; also SCRAP IRON.—MORGAN, 138, Gower-street, W.C. Museum 3418. P4569 F

WORK WANTED

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IRON CASTINGS (up to 15 tons each)

In Loam Dry and Greensand.
Machine Moulded Gear Wheels up to 10ft. dia.
Fly Rope Driving Pulleys, and Fly Spur Driving Wheel up to 28ft. diameter.
GEARING OF ALL DESCRIPTIONS.
Enquiries invited from Engineers and other users.
CLAYTON, GOODFELLOW & Co. Ltd.,
Engineers & Ironfounders, Atlas Works, Blackburn

MACHINING WORK WANTED.—
ENGINEERING WORKS with modern plant and own railway sidings, WANT REPETITION WORK; centre lathe work (up to 18in. centres), boring, drilling, shaping, plate working. Keen prices on receipt of sample or blue print.
Machined castings of finest quality in iron or gunmetal to customers' own patterns or drawings.
Open to manufacture any special machinery or small parts.
SALTERNS, Ltd., Engineers, Parkstone, Dorset. 6309 I

NEW MANUFACTURES WANTED.—An Old-established Engineering Firm intend to increase their scope of manufactures, and INVITE CORRESPONDENCE from responsible parties regarding such manufactures for which there is an immediate market. Undeveloped inventions will not be considered.—Address, P4523, The Engineer Office. P4523 I

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WORK WANTED

REPETITION WORK

WANTED

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CONSULTING ENGINEER.
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ONE PILLAR GIRDER RADIAL DRILLING MACHINE, by G. F. Smith, 2½in. spindle, 5ft. 6in. arm, 3 B.P.
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TWO 9in. Centres by 6ft. Straight Bed S.S. and S.C. LATHES, by Lang and Sons.
ONE Portable Hydraulic RIVETING MACHINE, "Scissors" Type, 54in. gap.
ONE Patent 40in. COLD IRON BAND SAWING MACHINE, by Noble and Lund.
TWO ¾-Cwt. STEAMER HAMMERS, by Massey.
TWO ¾-Cwt. PNEUMATIC HAMMERS; makers, Pilkington and Player.
ONE SLOTTING MACHINE, 9in. stroke, by Asquith.
ONE CANTING RADIAL DRILLING MACHINE, 3ft. radius, 2½in. spindle, by Muir, of Manchester.
PUNCHING and SHEARING MACHINES, 42in. long; PLATE PLANERS, 32ft. long; and other SHIPYARD PLANT.
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ONE 2-Cwt. Belt-driven SPRING HAMMER.
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100 K.W. GENERATING SET, by Scott and Mountain, Compound Engine direct coupled to Three-phase Generator, 550 volts, 50 cycles, 174 amps.
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CROSS COMPOUND HORIZONTAL ENGINE, 11in. and 19in. cyls., 24in. stroke, by Marshall, Sons and Co., Ltd.
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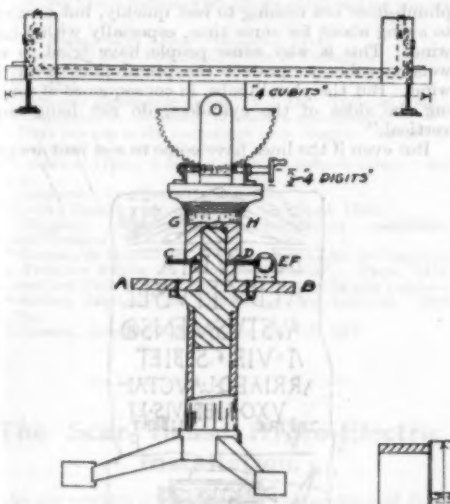
For continuation of For Sale Advertisements see page iii

Greek and Roman Engineering Instruments.*

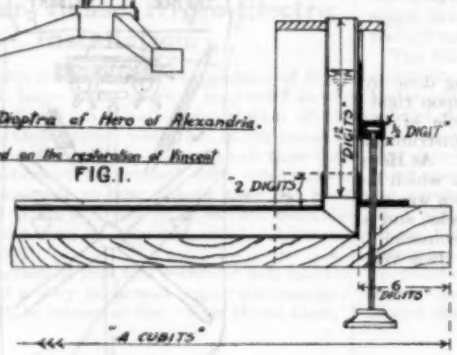
By R. C. SKYRING WALTERS, B.Sc., Assoc. M. Inst. C.E.

INTRODUCTORY.

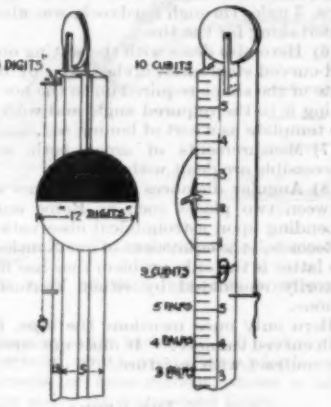
THE object of this paper is to give some account of the ancient field instruments, used by a fine race of engineers, for setting out such works as roads, canals, sewers, tunnels, harbours, reservoirs, and aqueducts, the remains of which are still to be seen in more or less good condition. So far as is known, only part of one of these old surveying instruments is in existence, but accounts of their use and construction which have come down to us remain. There are, moreover, many contemporary references to them. Thus, Frontinus (A.D. 100), engineer of the Roman water supply and sometime Governor of Britain before Agricola, alludes to them; Vitruvius (B.C. 25) gives practical reasons why he prefers some to others; and the Greek Heron, or Hero of Alexandria (between B.C. 100 and A.D. 100) wrote a text-book on the subject, describing an instrument called the "Dioptra."



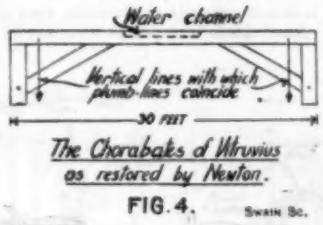
The Dioptra of Hero of Alexandria.
based on the restoration of Vincent
FIG. 1.



The Water-level of the Dioptra of Hero of Alexandria.
FIG. 2.



Levelling staff of Hero of Alexandria based on the restoration of Vincent.
FIG. 3.



The Chorabates of Vitruvius as restored by Newton.
FIG. 4.

"THE ENGINEER" SWAIN Sc.

HERO'S BOOK ON THE "DIOPTRA."

There are three existing MSS. of this book; one in Paris, one at Strasbourg, and one at Vienna, which is incomplete. Part of the text was published by Venturi[1] in Italian in 1814, a full text in French by Vincent[2] in 1858, and a third in German by Schöne[3] in 1903. There is also a short description by Truesdell in the American *Journal* of Association of Engineering Societies, 1897, and the author gave extracts in a paper read at a students' meeting at the Institution of Civil Engineers in 1914. Many little practical details are given that prove this ancient writer not only knew his job, but wrote his descriptions with the instrument before him. The following passages are a free translation, from M. Vincent's version, of the introductory paragraphs:—

THE DESCRIPTION OF THE LEVEL AND STAFF.

The construction of the Dioptra is as follows—Fig. 1:—

A stand is made resembling a small column which has on the top a cylindrical pivot. On this pivot is fixed, concentrically, a small circular copper plate. Higher up the pivot is a copper sleeve which turns easily on it; at the bottom, this sleeve is fixed to a toothed wheel which is smaller than, and rests upon, the copper plate; and on the top, for appearance, is a plinth of a small Doric column in the form of a miniature capital. Gearing with the toothed wheel is a small worm whose bearings are fixed to the copper plate.

A groove wider than the width of the teeth is cut in the worm so that if one turns the latter until the groove is opposite the teeth, the toothed wheel will be quite free to turn; and having thus put the wheel roughly in position, the worm can be turned until its thread gears with the teeth of the wheel, which is thereby locked[4].

On the plinth, two vertical uprights, made of copper, are fixed at a distance equal to the thickness of another toothed wheel whose axle passes through them, and on the same plinth between these two large uprights is a movable worm[5] whose small bearings are attached to the plinth. Between these two parallel uprights is the axle, four digits (3in.) above the top of the plinth.

In the space between the uprights there is a long rod or alidade, four cubits (6ft.) in length, supported at the middle, of the necessary width and depth. At the top of the alidade is cut a semi-circular or rectangular groove large enough to take a copper tube about twelve digits (9in.) shorter than the alidade—Fig. 2. At each end of this, another tube, two digits (1½in.) long, is fixed at right angles, which appears to be only a bend of the former. A piece of wood, fitting upon the groove, holds the copper tube tightly in place and makes a neat job. In each bent-up end is a small glass tube, about twelve digits (9in.) high, of such a diameter to fit into the copper tube, the connection with the latter being made water-tight with wax or some such material.

Two small boxes are attached near each end of the alidade to support and fix firmly the glass cylinders which go through them, and they have grooves cut in their sides for metal plates to slide up and down. These sliding plates touch the glass cylinders, and they have apertures for looking through at their centres. Small cylinders, about half a digit (¾in.) high, are fastened to the bottom of the plates in each of which a copper rod engages. This rod is equal to the height of the box supporting the glass tube and goes through a hole in the alidade, and has a screw thread cut on it which gears with a small piece attached to the alidade.

Then if we turn the head of this (vertical) rod, we will, by this means, move the sliding metal piece, with the aperture, up or down, for the metal piece end of the rod is provided with a little cap which turns in a groove on the inside of the little cylinder.

Having described the construction of the Dioptra, we will now speak of the staves and discs which accompany it—Fig. 3.

Two pieces of wood are cut which are ten cubits (15ft.) long, five digits (3¾in.) wide and three digits (2¼in.) thick. In each is cut a dovetailed groove down the whole length of the broad side, the short side of the dovetail being outside. In this groove a tenon runs freely without coming out, carrying a circular disc ten or twelve digits (7½in. to 9in.) in diameter, which is divided by a straight line, perpendicular to the length of the rod, into two semi-circles, one of which is painted black, the other white. To the tenon is attached a cord which passes over a pulley on top of the staff and goes down the other side of the staff remote from that of the disc.

Now, if one holds the staff in a vertical position and pulls the cord from behind, one makes the disc rise; if, on the contrary, one loosens the cord, the disc will descend by its own weight, especially if there has been nailed a plate of lead at the back of the disc, for this will cause it to move more quickly. Consequently, by means of the cord, the disc can be manipulated to any desired part of the staff. It is necessary to divide the length of the staff, from the bottom, into cubits, palms and digits[6]. At these divisions lines are drawn on the side of the staff to the right of the disc. The disc carries a pointer on the back in line with the diameter, which points to the graduated divisions marked on the side of the staff.

The staff must be held in a truly vertical position. This is ensured by there being fixed (on the plain side opposite the graduated side, *i.e.*, the left side of the disc) a small rod about three digits (2¼in.) long, at the end of which is a vertical hole, through which a string passes carrying a weight. Near the bottom of the staff is another small rod of a length equal to the distance of the hole from the staff on the top rod, and on the end of this is marked a vertical straight line. When the plumb-line coincides with this line it will show that the staff is truly vertical[7].

LEVELLING.

The following description of Hero's is quoted *in extenso*, as it must have been applicable to the alignment of ancient aqueducts whose lengths totalled hundreds of miles.

Let B be the source of the water and A the place to where it is to be brought. At A place one of the staves A C, set up the Dioptra as far as possible from A in the direction of B, so that the staff A C can just be seen, and turn the alidade (which carries the glass cylinders) until it points to A C. Then by turning the screw which is inserted in the alidade, raise the metal plates until the apertures are opposite the lines of the surfaces of the water contained in the glass tubes. The metal plates being in this position, look through the apertures in them and have the discs on the staff A C raised or lowered until the line which divides the black half from the white is seen.

Leaving the Dioptra thus, go round to the other side of it, and sight on to another staff which is as far as possible from the Dioptra, and again set in line the dividing line of the discs of the staff. Let D E be the second staff, F the Dioptra, C and E the points determined by the line of sight of the Dioptra, D the point where the second staff is placed on the heights A C and D E are noted, suppose A C is six cubits and D E two. Then in the two columns headed "Backsight" and "Foresight" write "6" in the Back column and "2" in the Fore'.

The staff D E being kept in position, the Dioptra is set up at G, and a distance D H = 4 is read as a backsight and a distance 2 on the foresight stave. The process being continued till B is reached, all the backsights and foresights are added up, the difference being found to be, say, ten cubits. Now, as the sum of the backsights (*i.e.*, a number which represents the ground in the direction to where the water is to be led) is greater, the water will flow; for at B the ground is ten cubits higher than at A.

As to the intermediate places over which we propose to conduct the water, we shall get their levels relative to each other or to the end places, in exactly the same method by treating any given point as if it were one of the end places. Having made these calculations for the whole length, the gradient must be found at every point, and marked levels, bench marks, put in at various points, so that there shall be no error anywhere on the job.

Vitruvius, in his "Seventh Book on Architecture,"[8] with reference to aqueducts, speaks of levelling apparatus—Fig. 4:—

"I shall now describe how water is to be conveyed to houses and cities, for which purpose levelling is necessary. This is performed either with the Dioptra, the water level, or the Chorobates. The latter apparatus is, however, the best, as the Dioptra and level are often found to be incorrect. The Chorobates is a rod twenty cubits (30ft.) in length, having two legs at its extremities of equal length and dimensions and fastened to the ends of the rod at right angles with it. Between the rod and the legs are cross pieces fastened with tenons, whereon vertical lines are correctly marked, through which corresponding plumb-lines hang down from the rods When the rod is set, these will coincide with the line marked, and show that the instrument stands level. But if the wind obstructs the operation and the lines are put in motion, so that one cannot judge by them, let a channel be cut on the top of the rod five cubits (7ft. 6in.) long, one digit (¾in.) wide, and half a digit (⅜in.) deep, and let water be poured into it. If the water touch each extremity of the channel equally, it is known to be level. When the Chorobates is thus adjusted level, the inclination may be ascertained."

Vitruvius's criticism is a little misleading, for we might just as well say that a builder's straight-edge

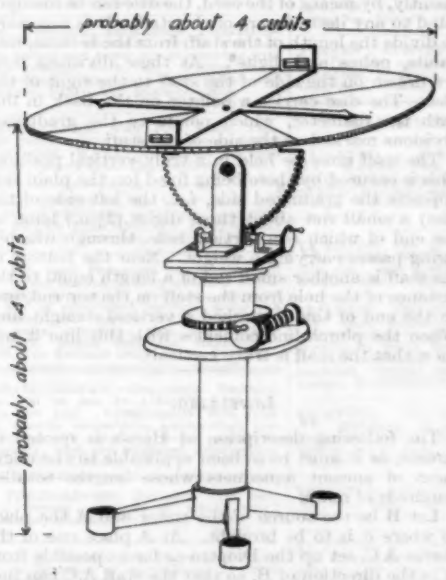
* Paper read before the Newcomen Society on Thursday, December 15th. Abridged.

with level is more accurate than the Dumpy level or boning rods. The straight edge and level is intended to be used over small distances and the dumpy or boning rods over large ones.

Such instruments must have been used long before the time of Hero; thus in his preface he says that the Dioptra is an improvement upon previous instruments.

ALIGNMENT.

Hero's description of the Dioptra and its use for levelling is immediately followed by problems of



Hero's Dioptra as used for setting out lines at right angles.

"THE ENGINEER" FIG.5 SWAIN SC.

setting out lines at right angles to each other. They refer to what seem to be modifications of the same instrument which have not been described above, namely, to a large horizontal circular plate which is attached to the vertical circle—Fig. 5. This large circular plate was divided by two lines at right angles for ordinary setting out and surveying, and into 360 deg. for the measurement of angles between stars.

Further, a sighting apparatus rotated about a pivot at the centre of the plate, which Schöne has called a simple alidade, thereby replacing the water level with its sighting strips; but this is quite unnecessary, as the levelling apparatus with its sighting strip, described above could have been used quite as well, for the glass tubes could have been taken out and this explains the necessity for making a temporary joint with wax between the glass and copper tubes.

Hero's twenty problems are minute in detail both as regards the setting up of the instrument and the method of carrying out the work in the field, and show clearly the construction of the different parts, which has been a great help in the reconstruction of the apparatus, Hero's original drawings not being in existence.

The applications may be grouped as follows:—

(1) The setting out of a connecting line between two points which are invisible from each other.

(2) The determination of a horizontal distance from an inaccessible point, distances between inaccessible points, breadths of rivers, &c.

(3) Setting out horizontal distances by means of a graduated pole placed near the instrument and sighting on to it by turning the alidade in the vertical plane by means of the vertical half circle.

(4) The determination of the heights of inaccessible points above the horizontal, heights between inaccessible points, heights of ramparts, depths of ditches, valleys, &c.

(5) *Tunnelling, Straight and Curved.*—The tunnels are bored from both ends "so that the workmen will meet each other," or from many places at once by shafts. That tunnels were driven simultaneously from both ends is proved by the Shiloah tunnel (580 yards), built by Hezekiah in B.C. 700; the tool marks run in opposite directions from both ends until about the middle. A notable tunnel was dug—B.C. 600—for bringing water to Samos from a spring in a hill a mile away. This tunnel was 8ft. square, with a trench 2ft. wide having a varying depth up to 30ft., because the slope of the tunnel was not the same as the trench in which the pipes were laid. It was constructed, Herodotus tells us, for Polycrates by Eupalinus, a contractor of Megara. A water-supply system in clay pipes, without tunnels, was constructed by the same firm a few years later at Athens. At Naples there was a road tunnel 2316ft. long, 22ft. wide, and 89ft. high. Lake Fucino drainage to the Liris, 3 miles through hard rock, was also a wonderful undertaking for the time.

(6) Hero also deals with the setting out of harbours and curved structures, arches, &c., by bolting a template of the shape required on to the horizontal circle, tilting it to the required angle and with a pole, using the template as a sort of boning rod.

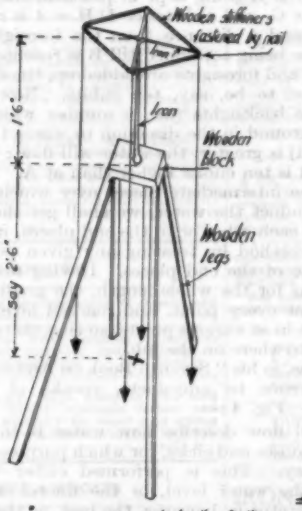
(7) Measurements of areas both accessible and inaccessible are dealt with.

(8) Angular distances between stars and distances between two places such as Rome and Alexandria depending upon astronomical observations and some "Records," the equivalent of our Nautical Almanack; the latter is the only problem that has not been satisfactorily elucidated by either Venturi, Vincent or Schöne.

Hero only once mentions the *tape*, in connection with curved tunnels: "It must not stretch on pulling nor contract with moisture."

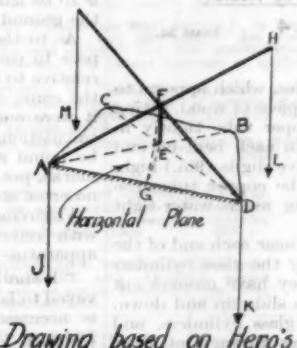
THE GROMA.

Nearly all the setting out and surveying done by engineers in the time of Hero depended upon right-angled triangles; consequently, the whole of the efficiency of the work depended upon an instrument to give right angles quickly and accurately. As Hero criticises unfavourably another instrument which he calls the "star"—it seems that the Dioptra was not by any means exclusively used by the Greeks, and it is known that the Roman surveyors ("Gromatici") used an instrument called the "Groma." It is very probable that the "star" and "groma" are one and the same instrument. Scholars have not satisfactorily reconstructed the instrument, but as it is of some importance the following facts are put before members about the instrument, with a suggested drawing of it—Fig. 6.



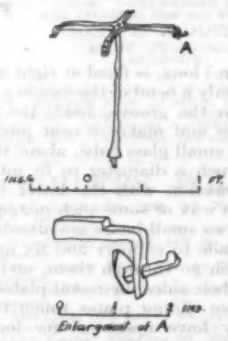
"Groma" as reconstructed by the Author.

"THE ENGINEER" FIG.6.



Drawing based on Hero's description of the "Star."

FIG.7.



Remains of Iron Groma.

FIG.8. SWAIN SC.

It is alluded to as the Groma, or Ferramentum (iron) in books describing military operations and the setting out of fortifications, *e.g.*, Hyginus.[9] "At the entrance of the headquarters of the staff half-way along the main road, there is a place called the "Place of the Groma"—because of the crowd which gathers there. The Groma is set up on its iron stand with its plumb-lines in position so that the entrances to the fortifications may be seen from the 'star' when the straight lines connecting them are set out. Experts in this art are called Gromatici, for the reason given above."

From what Frontinus says in the "Gromatici Veteres," it is thought to be a movable plate pivoted on to a stand.[10] At the four extremities of two diameters hang plumb-lines, which were sighted in line, the instrument being used for setting out lines at right angles. He says:—"To use the instrument we must steady all the plumb lines and look at the cords or strings stretched by the weights, setting them in a line until the eye sees the nearest only. Then put in the stakes, and having carried the apparatus to the last stake, set it up as before and look at the stakes in the opposite direction by way of a check. Then, to continue the staked out line when intercepted by obstacles, carefully set out the right angles given by the plumb-lines by perpendicular lines at every point of interception."

Hero's condemnation is as follows:—"Many people use the so-called 'star' a great deal for a few of the operations performed by the Dioptra, and if we have occasion to use this instrument for the carrying out of such operations, the theory of its use is given here, so that people may not make mistakes through ignorance. I think that those who use this apparatus find serious inconvenience which results from the plumb-lines not coming to rest quickly, but continue to swing about for some time, especially with a high wind. This is why some people have tried to use wooden tubes to protect the plumb-lines from the wind. But the plumb-bobs, in consequence of touching the sides of the cylinders, do not hang truly vertical."

But even if the lines have come to rest and are perpendicular to the horizon, the planes containing the lines are not always at right angles to each other, and consequently it follows that the operation will not be performed correctly. This will be seen as follows—Fig. 7:—

Tombstone showing Groma.

"THE ENGINEER" FIG.9 SWAIN SC.

Let there be two lines in a plane, A B and C D, which do not cut each other at right angles, and let A E D be an obtuse angle. At the point E erect a line E F which is at right angles to the plane containing A B and C D; it is therefore perpendicular to both the lines A E and E C. Now the angle A E C is the inclination of the plane A E F to the plane C E F, and is an acute angle.

Make A E = E D. Join A D.

Drop the perpendicular E G on to it, making G A = G D.

As both these lines are greater than G E (the angles at G being right angles), it is possible to make G F = G A.

Join A F and D F.

∴ The angle A F G = D F G = 45 deg.

Produce A F and D F to H and I respectively.

Then A H is perpendicular to D I.

Draw A J, D K, H L, I M parallel to E F.

If we suppose that the arms of the star are A H and D I, and the plane containing the lines A B, C D is horizontal and the strings hung at A J, D K, I M, H L, then the plane containing A J and H L (that is, A B) is not perpendicular to the plane containing D K and I M (or D C), for these planes were made inclining to each other at an angle A E C, which is an acute angle.

The remains of an actual Groma were discovered in Bavaria,[11] consisting of a central rod 18in. high and

four cross arms 9in. each. The four ends of these rods are turned down, drilled, and a long nail inserted in each hole—Fig. 8. An interesting discovery of a Roman tombstone[12] was made at Ivrea (near Turin) of a certain Aebutius Faustus, presumably a surveyor—Fig. 9. On it is represented a design most probably the Groma. There are only two plumb-bobs shown, however, and the stone where the ends of the cross pieces are is worn down. The character of the lettering bears the date of the tombstone as early in the first century, and that it was made in the lifetime of the surveyor is shown by the letters "V. F.," which stand for *Vivus facit.*

Summing up, we have seen that setting out and surveying up to about A.D. 100 was carried out by the Greeks and Romans with the Dioptra, Chorobates and forms of water level for levelling; and by the Dioptra and Groma for all kinds of surveying and the setting out of lines and lines at right angles to each other. We have also seen that there are many striking points of similarity not only in instruments but in the methods employed 2000 years ago with those of the present day. Modern refinements may be necessary for modern requirements, but the old were evidently efficient enough for the erection of those beautiful structures the remains of which we see standing to-day.

[1] "Il traguardo di Erone" (Bologna, 1814).
[2] "Le traité de la Dioptre de Héron d'Alexandrie" (Notices et Extraits des Manuscrits de la Bibliothèque Impériale, Vol. XIX., 1858).
[3] "Heronis Alexandrini Opera," Vol. III. Teubner, 1903.
[4] Comparable to the clamp of modern instruments.
[5] There is a gap in the manuscript here. Supply "to turn the toothed wheel in a vertical circle."
[6] 1 cubit = 17¾in.; 1 foot = 11¾in.; 1 palm = 2¾in.; 1 digit = ¾in.
[7] Comparable to a modern plumb rule.
[8] Gwilt's English version. Crosby Lockwood, 1860.
[9] "Hyginus Gromaticus de munitionibus castrorum." Gemoll (Teubner), 1879.
[10] Germain de Montauzan. "La Science et l'Art de l'Ingénieur aux Premiers Siècles de l'Empire Romain." (Paris, 1919). An excellent little book to which we are very largely indebted.
[11] Schöne, Jahrbuch des Archaeologischen Instituts. 1901. (Berlin.)
[12] Ganzera, Accad. di Torino, Serie II., Vol. XIV.

The Scar House Hydro-Electric Installation.

As our readers are aware, the Corporation of Bradford possesses large water storage reservoirs in the valley of the Nidd. A detailed description of the waterworks in that district was given in our issues of March 12th and 19th, 1915. It has since that date been found necessary to proceed with construction of a further reservoir at Scar House, near the head waters of the Nidd, and just down-stream from the existing Angram dam, in order to provide additional storage capacity.

The construction of this new reservoir will involve the building of a very large and important masonry dam, which will be known as the "Scar House Dam," and in order to provide the necessary energy to run the cranes, overhead ropeways, crushing plant and other machinery involved in the work, Mr. Lewis Mitchell, M. Inst. C.E., the Corporation's waterworks engineer, conceived the idea of utilising the water flowing from the Angram reservoir to operate a hydro-electric plant. It may be recalled that the water from Angram reservoir flows into the river Nidd, and about two miles down stream from the dam is conveyed from that stream into the Rainstang Tunnel, through which it passes to the Bradford service reservoirs.

The contract for carrying out this work was secured in open competition by Vickers Limited in November, 1920, the designs advanced by that firm being considered to be the most practical and economical of any that were submitted. The generating plant comprises two Francis type turbines made at the firm's Naval Construction Works at Barrow-in-Furness, to the designs of its associated works—Les Ateliers des Charmilles S.A., Geneva (late Piccard Pictet). Each turbine was designed for the following general running conditions :—

Net head, feet	168
Output, brake horse-power	295
Discharge, cubic feet per second	19.5
Speed, revolutions per minute	1000

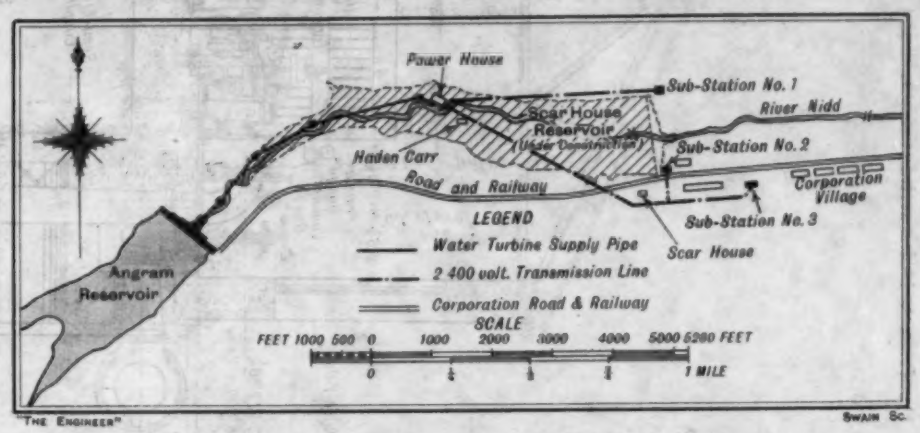
Owing to the possible variations in level in the Angram reservoir, these turbines are also capable of working under a head of 207ft., with the same output and a correspondingly reduced discharge, and under a head of 148ft. with correspondingly reduced output.

The guaranteed efficiencies of these turbines under a net head of 168ft.—subject to a tolerance of plus or minus 2 per cent.—were as follows :—

	Per cent.
Full load, 295 brake horse-power	79
Seven-eighths load	80
Three-quarter load	79
One-half load	76

We are informed that during tests recently completed the efficiency of the turbine at full load worked out to 86.5 per cent., which, even allowing for possible slight inaccuracies of measurement, shows a satisfactory margin above the guaranteed figure.

The turbines are controlled by two oil pressure governors, made in accordance with the Piccard Pictet patents, which work each in conjunction with a relief valve, each turbine having its own governor and its own relief valve. The arrangements are such that should the load be suddenly thrown off, the relief valve opens very quickly and begins to open before the governor commences to close the turbine gates, after which it—the relief valve—closes very slowly, taking between 80 to 100 seconds to do so after opening in from 2 to 3 seconds, thus ensuring—as, we understand, has been fully proved by the recent tests—that the over pressures in the pipe line will not exceed about 14 per cent. of the final static head.



SKETCH PLAN SHOWING RELATIVE POSITIONS OF ANGRAM RESERVOIR AND THE POWER HOUSE

The general arrangement of the machinery in the power-house is shown in the drawing on page 640. Coupled to each of the water turbines by means of a semi-elastic coupling is an open-type three-phase generator with an over-hung exciter. Each machine is designed for a continuous output of 250 k.V.A., or 200 kilowatts at 0.8 power factor, 2400 volts, 50 cycles, when working at 1000 revolutions per minute, and each generating unit has, so Messrs. Vickers inform us, been tested in the works with an over-speed of 80 per cent. The excitation voltage is 110 and the efficiency at full load and 0.8 power factor on each generator is given as being 93 per cent. A fly-wheel is provided on each generating unit in order to prevent the necessity for having the more expensive electrical machines which would be necessary if the whole of the fly-wheel effect required were embodied in the rotating members of the alternators.

The current is conveyed to the switchboard by high-tension single-core rubber-insulated 3300-volt Association-grade cables made by Messrs. Vickers' associated works, Messrs. W. T. Glover and Co., of Trafford Park, Manchester, who have supplied all the cable connections in connection with this contract.

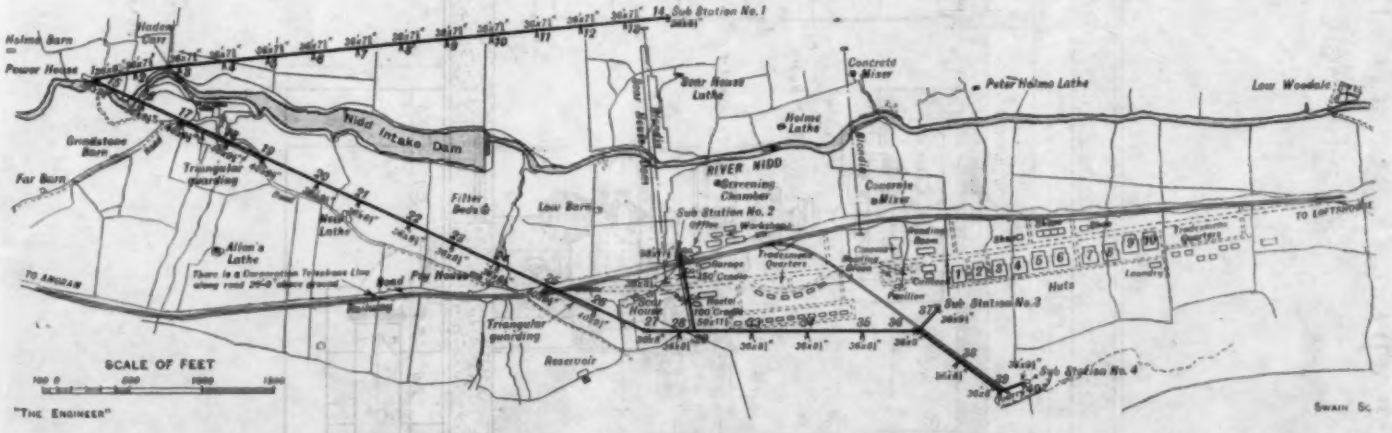
The six-panel switchboard by the Metropolitan-Vickers Electrical Company, of Trafford Park, Manchester, comprises a synchronising bracket, an exciter cubicle, controlling the two exciters, two generator cubicles, and two feeder cubicles, each of which is capable of dealing with the full output of the power-house, and finally a voltage regulator and lighting cubicle. The lighting in the power-house is supplied by a 0.5 k.V.A. single-phase transformer.

When the installation is complete current will be conveyed for subsequent distribution to four sub-stations. Two of these sub-stations, Nos. 1 and 4, are duplicates of one another as far as equipment is concerned, although as a matter of fact the position of No. 4 is not as yet absolutely settled, as it depends upon the final choice of the quarry site.[7] Each of these sub-stations will contain :—Four 50 k.V.A. three-phase transformers with a ratio of 2200/440 volts. These transformers are star/star connected, oil immersed in corrugated sheet iron tanks of the self-cooled type. Each of these two sub-stations will contain the necessary isolating links, lightning arresters and choking coils on both the high and low-tension sides. As regards switchgear, on the high-tension side there are four 50 k.V.A. transformer cubicles, while on the low-tension side there is a three-panel switchboard, two panels of which will each control two 50 k.V.A. transformers, the third panel dealing with one 50 k.V.A. and one 200 k.V.A. feeder. The whole of the electrical equipment in these two sub-stations as well as that in the other sub-stations was supplied by the Metropolitan-Vickers Company.

Sub-station No. 1 is situated at the far end of the new dam site, that is to say, remote from the Corporation offices and village.

Sub-station No. 2 is placed near the Corporation offices at the railway end of the new dam site, and as it has to supply the workshops and overhead ropeways, &c., as well as a certain proportion of the cranes on the dam, it is of a somewhat larger capacity than Sub-station No. 1, though in general arrangement it is very similar. It contains five 50 k.V.A. transformers and five high-tension transformer cubicles. The low-tension switchboard consists of four panels, two of which each control two 50 k.V.A. transformers, while the third deals with one 50 k.V.A. transformer and one 100 k.V.A. feeder, and the fourth panel with two 200 k.V.A. feeders.

Sub-station No. 3 is situated at the back of the Corporation village, and is of a different character from the others, because it is intended solely for lighting. To meet the requirements of the Bradford Corporation waterworks, a village of huts has been

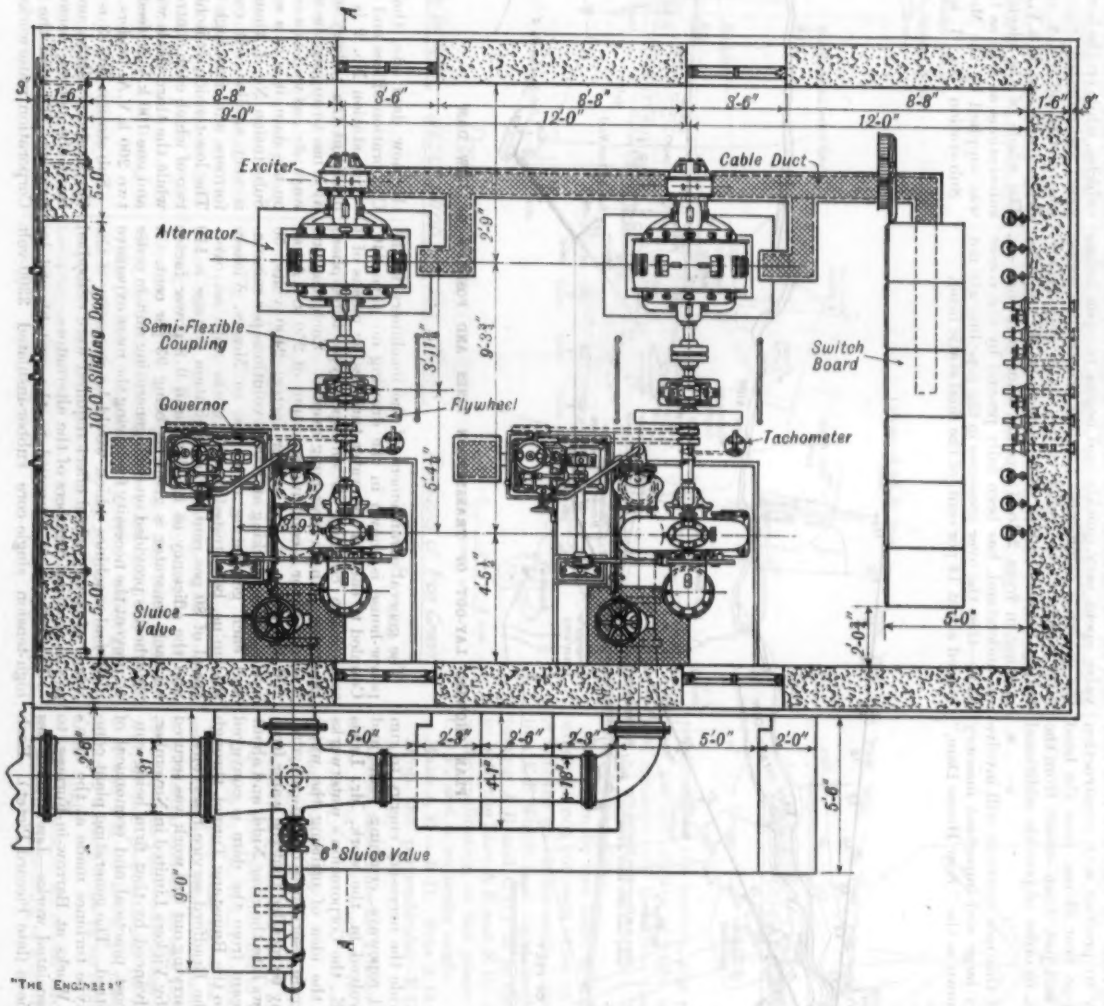


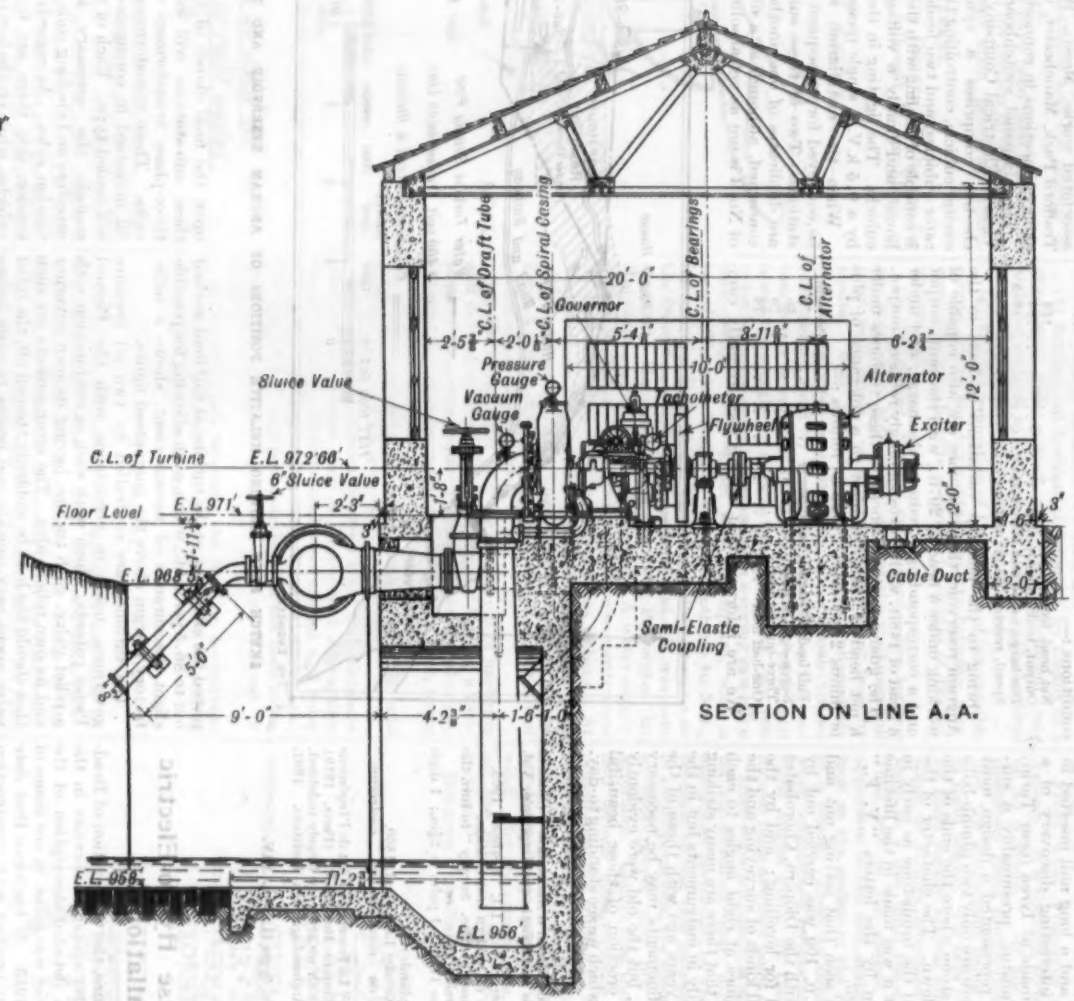
PLAN SHOWING LAY-OUT OF TRANSMISSION LINES AND POSITION OF NEW DAM

SCAR HOUSE HYDRO-ELECTRIC INSTALLATION OF THE BRADFORD CORPORATION

MR. LEWIS MITCHELL, M. INST. C.E., BRADFORD, AND VICKERS LIMITED, ENGINEERS

(For description see opposite page)





PLAN AND CROSS SECTION OF THE POWER HOUSE

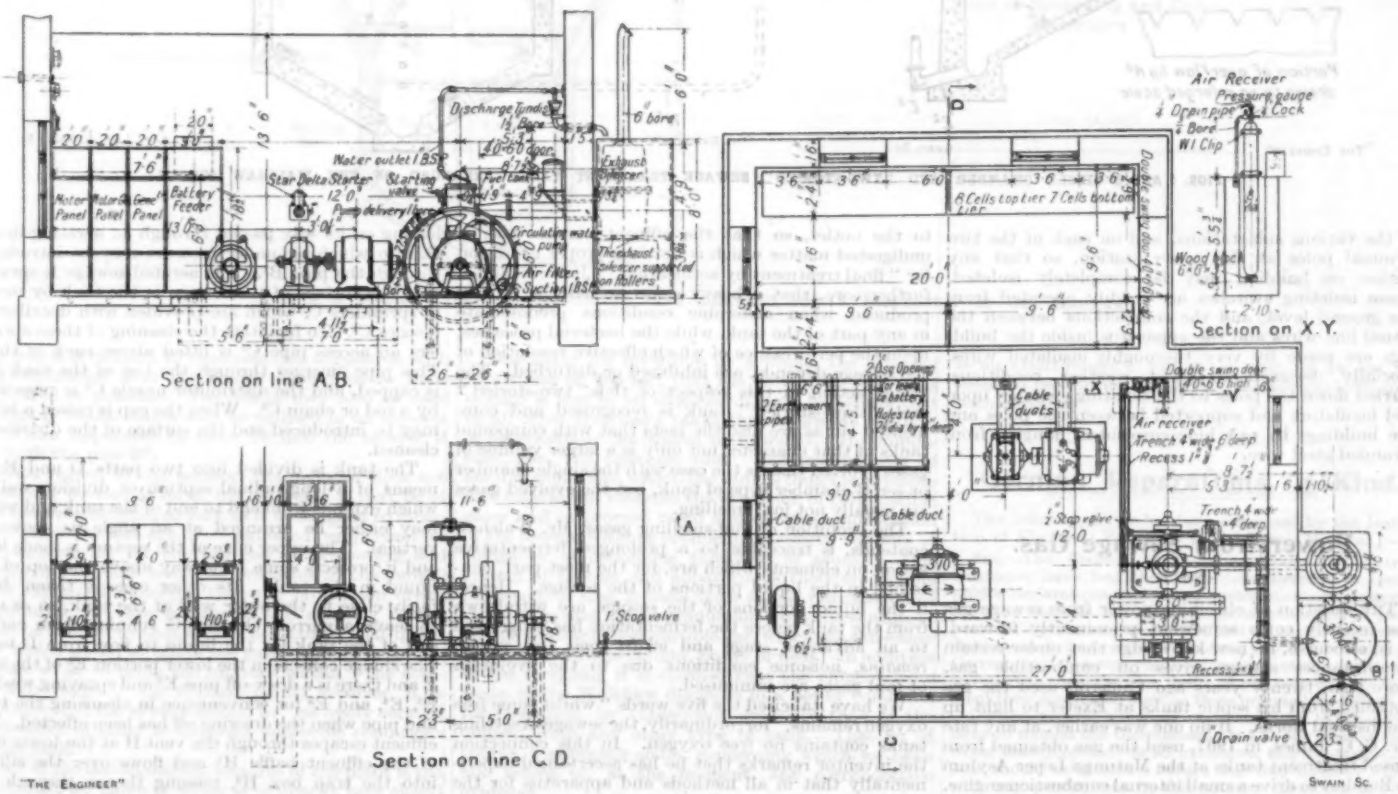
built for the use of engineers on the site. The lighting is to be done at 110-volts direct current, and the sub-station—the general arrangement of which is shown below—comprises the following equipment :—

The high-tension line is brought in to a cubicle similar to those in the other sub-stations, which controls a 25 k.V.A. transformer. This transformer is used for feeding a 20-kilowatt motor gene-

INTERIOR OF SCAR HOUSE HYDRO-ELECTRIC GENERATING STATION

rator, which can either charge the battery or supply current for lighting direct. As a stand-by and for use when the water turbine plant is not running for any reason, a belt-driven generating unit, also of 20-kilowatt capacity, operated by a 35 horse-power Vickers-Petter hot-bulb crude oil engine, has been installed. It is furnished with an electric starter and compressed air apparatus. This generating unit is also capable of either charging the battery or supplying the lighting circuits direct. The low-tension switchboard to control this equipment consists of one motor panel for the low-tension side of the transformer and the motor of the motor generator, one generator panel for the direct-current generator of the motor generator set, one generator panel for the belt-driven generator, and one panel for the control of the storage battery and the lighting feeder.

As an annexe of this sub-station, there is a battery room containing a "Chloride" battery of sixty cells in glass boxes. The battery when fully charged will be capable of giving a discharge of 979 ampère-hours in ten hours to a final pressure of 1.83 volts per cell, 816 ampère-hours in five hours to a final pressure of 1.78 volts per cell, and 701 ampère-hours in three hours to a final pressure of 1.75 volts per cell. The ampère-hour efficiency of the battery is given as being 90 per cent. at all rates, while the watt-hour efficiency is 75 per cent. at the ten-hour rate. The buildings, which are all of the most simple design, were constructed by a local sub-contractor under the supervision of Messrs. Vickers' resident engineer, and do not call for any comment. They consist of rubble masonry, and local stone was used so that they harmonise with such few buildings as exist in the valley, and present a workmanlike appearance. Some slight trouble was experienced in putting in the foundations of the power-house and tail-races on the river bank, mainly owing to the fact that the rock and material encountered was of a soft and broken nature and somewhat difficult to blast. These little troubles, however, were easily overcome, and the buildings are of an extremely solid character. Two ex-



CROSS SECTIONS AND PLAN OF SUB-STATION No. 3

terior views of the power-house are given on page 650.

The pipe line between the dam and the power-house is nearly one mile long. There are two connections made to it from the reservoir, one to an existing 30in. pipe in a culvert in the dam controlled by an 18in. valve in the Corporation valve house, and the other an 18in. pipe just down stream of the Corporation's measuring weir below the dam, controlled by another 18in. valve. From the cast iron 30in. pipe inside the dam 30in. bore steel pipes $^{5}/_{16}$in. thick have been laid down to the point where the other 18in. pipe joins at a branch in pipe No. 17. An air valve is provided on pipe No. 12 to free any air which may collect in the pipe, and for the escape of air when the pipe is being filled. This valve also prevents the formation of a vacuum in the pipe line should the latter be emptied too quickly. At pipe No. 17 the pipe line proper begins. The 30in. diameter pipe up to and including pipe 17 is approximately 312ft. long. Following it there is a section approximately 1484ft. long of 35in. bore pipe, $^{3}/_{16}$in. thick; which, in turn, is followed by a section approximately 1488ft. long, of 33in. bore pipe 0.2in. thick, while the final length is approximately 1491ft. long of 31in. bore pipe $\frac{1}{4}$in. thick. The total length of the pipe line is 4775ft., and the pipes are of the mild steel welded type with flanges riveted on. The three sizes were nested for ease of transport, the two smaller bores in each case being supplied with loose flanges on one end, which were riveted on on site. Concrete anchor blocks, anchoring rings and expansion joints at the necessary points are provided. Views of the pipe line are given on page 650.

The pipe line is supported where necessary on rubble masonry piers and concrete saddles, free movement being provided for by inserting tough brown paper served with black lead and tallow between the pipe and the concrete saddles. The pipe line in its course to the power house follows approximately the path of the river Nidd, which it crosses five times, temporary wooden bridges being erected at the crossings. The pipes were coated both outside and inside with hot tar asphalte before dispatch from the works, and after erection on site they were painted with special Cuirass Products paint. It is interesting to note that a maximum expansion joint movement of 3$\frac{1}{4}$in. during one twenty-four hours was observed last autumn when the pipe was empty, and when it was hot in the valley during the day and very cold at night. Just before entering the power-house a small 2in. drain valve is provided in the bottom of the pipe line to drain the last section if it should ever be required to empty it completely. In case the water power-house is shut down completely for any reason, a 6in. discharge valve, connected by a tapered pipe to a 15in. pipe discharging into the river Nidd has been fitted. The reason for this provision is that in ordinary operation the water supply to the city of Bradford will go through the turbines, and that if they are not running for any reason the water supply must, of course, continue. In this connection it may be mentioned that the ordinary consumption from the Angram reservoir is 13 cubic feet per second over twenty-four hours. As it is required to get as much energy as possible during eight hours out of the twenty-four, the turbines were designed to utilise approximately three times that amount, and, in

consequence, it has been necessary for the Bradford Corporation to heighten the small dam on the regulating reservoir a little down-stream of the power-house at the place where the water supply for the city from the Nidd is actually controlled before it passes into the Rainstang Tunnel referred to above.

The joints between the pipe line flanges, which are bolted together, are made with a rubber jointing material supplied by the Ioco Rubber and Waterproofing Company, Limited, Glasgow, a firm which also forms one of the associated works of the Vickers combination.

The run of the transmission lines—a large portion of the material for which has been supplied by Twiss Electric Transmission, Limited, as sub-contractors to Vickers Limited—is shown on page 639. The lines are of the simplest possible character, wooden poles of the "A" and "H" descriptions being used. The wires actually conveying the energy are of stranded copper, and there is a continuous earth wire provided throughout. Cradles and triangular guarding are provided at such places as render such precautions necessary, as, for example, where either roads or railways are crossed by the 2400-volt transmission. The lines are very strongly guyed and supported, in consequence of the heavy wind and weather conditions which frequently obtain at the head of the Nidd Valley. An extra large section of copper has been used in all cases, because it is desired to use to the utmost the available power, a consideration which justified a somewhat abnormal expenditure on copper. The line, of course, is at a comparatively low tension for transmission of this character, and there is nothing remarkable about it except its simplicity. There are isolating switches provided on each terminal pole, at the various sub-stations, and on each of the two terminal poles at the power station, so that any section or building may be completely isolated. These isolating switches are readily operated from the ground level, and the connections between the actual line wires and the apparatus inside the buildings are made by very thoroughly insulated wires, specially designed to resist weather conditions, carried down the poles to the isolating switches upon reel insulators and supported between the poles and the buildings by raw hide suspenders hanging from stranded steel wire.

Power from Sewage Gas.

No. I.

THE question of obtaining power from sewage gas has recently come somewhat prominently forward. It is, of course, no new knowledge that under certain circumstances sewage gives off combustible gas. More than twenty years ago Cameron used the gas obtained from his septic tanks at Exeter to light up the disposal works. If no one was earlier, at any rate Mr. C. C. James, in 1907, used the gas obtained from closed treatment tanks at the Matunga Leper Asylum at Bombay to drive a small internal combustion engine. In 1911 Mr. Horace Flicker, of Parramatta, in New South Wales, claimed to have discovered that the gas was more freely given off from sewage in a covered tank if the pressure above the tank was never allowed to rise above the pressure of the atmosphere; that is to say, if the gases were withdrawn as soon as formed. Mr. Flicker took out a patent in Australia—No. 1654 of 1911—in which he claimed the use on the top of the tank of a non-return air valve, the duty of which was to allow a certain volume of air to enter the space above the liquid in the tank so as (*a*) to take the place of the gases removed for power or other purposes; (*b*) to stir up the inert gases and mingle them with the combustible gases; and (*c*) to ensure that air was always in contact with the surface of the sewage in the tanks. We need not further discuss this particular patent, because in 1917 Mr. Flicker, who apparently afterwards assumed the name of Walshaw, took out a further patent, which not only embodied his non-return air valve, but a good many other features as well. The second patent was taken out in this country as well as others, and the number of the British patent is 111,401. Both patents are now the property of the Septic Gas Company of Australia, Limited, the representative of which in this country is Mr. W. A. Winchester, of Langton-road, St. Anne's Park, Bristol. In what follows, however, we shall, for the sake of brevity, refer to the system under the name of Walshaw.

The patent of 1917 not only claims special arrangements for the production of gas from sewage, but an improved method of purifying sewage as well. It is explained in the specification that it is found in practice that, when sewage is introduced into the lower part of a single-chamber purification tank, the period of rest to which the sewage is subjected is often indeterminate and governed by uncontrollable causes. Notwithstanding that the capacity of the tank in relation to the rate of flow of the sewage delivered to it may be proportioned with a view to the detention of the sewage for a predetermined period of rest, yet, after the tank has been operated for a considerable time the flowing sewage makes for itself a narrow and more or less direct course from the inlet to the outlet, and substantially no flow occurs through the other portions of the tank. This action results in a too rapid transfer of the flowing sewage from the inlet to the outlet, so that the effluent carries with it undigested matter which is not in a proper condition for "final treatment by aerification." It is explained, furthermore, that a heavy scum or crust is usually produced when anaerobic conditions predominate in any part of the tank, while the bacterial processes, upon the performance of which effective resolution of the sewage depends, are inhibited or disturbed. The better action in this respect of the "two-storied" and "three-storied" tank is recognised and commented on, as are also the facts that with compound tanks of that character not only is a larger volume of gases evolved than is the case with the single-chamber or serial-chamber type of tank, but the evolved gases are usually not foul smelling.

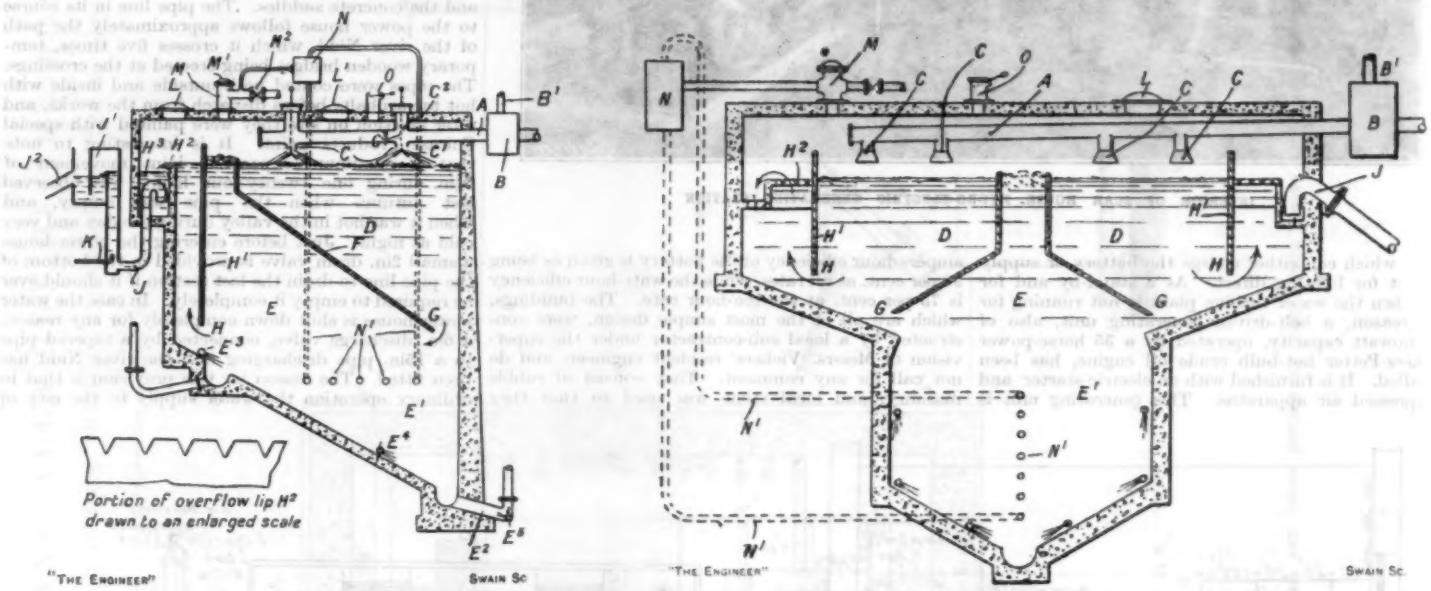
The evolution of foul-smelling gases, Mr. Walshaw contends, is traceable to a prolonged fermentative action on elements which are, for the most part, contained in the liquid portions of the sewage. Hence, if the liquid portions of the sewage are withdrawn from the tank before the fermentation has progressed to an advanced stage and *whilst some free oxygen remains*, noisome conditions due to the evolution of foul gases are minimised.

We have italicised the five words "whilst some free oxygen remains," for, ordinarily, the sewage in settling tanks contains no free oxygen. In this connection the inventor remarks that he has ascertained experimentally that in all methods and apparatus for the purification of sewage in which the sewage is introduced directly into a tank from the sewer or the collecting pits in which the sewer terminates, speedy and effective resolution of the sewage is slackened and curtailed because the sewage does not carry with it into the tank a sufficiency of oxygen to support the aerobic process on which its resolution mainly depends. He has, he adds, further, ascertained that the process of resolution may be hastened by providing means whereby the evolved gases are more rapidly removed from the sludge particles on or amongst which they are formed.

He concludes, therefore, to use his own words, that "given conditions in which a sufficiency of oxygen to support the aerobic fermentative processes is introduced into the tank with the sewage, and the fermentative processes are permitted to operate readily by the continuous withdrawal of the gaseous products of fermentation, and further, given conditions ensuring effective distribution of the sewage flow through the tank, (*a*) a limited sludge condition, (*b*) a hastening of the purification, and (*c*) an improvement in the purity of the effluent are obtained simultaneously with the production of large volumes of combustible gases and usually without the production of foul-smelling gases such as sulphuretted hydrogen, or with only a limited quantity of such noisome gases."

It is necessary, he remarks, that, irrespectively of the type of tank in which the resolution is being accomplished, the fermenting sludge shall be substantially digested, and, consequently, any method or apparatus for tank treatment that involves agitation—and by this he means violent agitation—of the sludge bed is objectionable. As we shall see, however, he does advocate the *gentle* agitation of the top layers of sludge with the object of disengaging from the particles of sludge in those layers the bubbles of gas which adhere to or surround them.

The specification contains illustrations of how the invention may be applied to various shapes and types of tanks, but if we refer to two of them only—those shown in Figs. 1 and 2—it will be sufficient for our present purpose. Fig. 1 is a section, more or less diagrammatic, of a rectangular tank in which the direction of flow of the sewage is transverse to the tank. The sewage enters the tank through the pipe A,



FIGS. 1 AND 2—SINGLE CHAMBER AND "TWO-STORIED" SEWAGE TREATMENT TANKS ARRANGED ON THE WALSHAW SYSTEM

having on its way passed through an aerating device B, into which air under pressure may be introduced through the pipe B^1. The aerated sewage is sprayed over the surface of the sewage in the tank by means of sprinklers C, which are provided with distribution nozzles C^1. To facilitate the cleaning of these sprinklers an access pipe C^2 is fitted above each of them. This pipe emerges through the top of the tank and is capped, and the distributor nozzle C^1 is suspended by a rod or chain C^3. When the cap is raised a brush may be introduced and the surface of the distributor cleaned.

The tank is divided into two parts D and E, by means of a longitudinal septum or division wall F, which extends from end to end of the tank and which may either be arranged at an angle as shown or vertical. The upper edge of the septum is made level and it projects some little way above the top of the liquid in the tank. Its other edge is taken down fairly close to the outer wall of the tank, so as only to leave a narrow channel G running from end to end of the tank for the liquid to flow from D to E. The sludge collects in the lower portion E^1 of the tank E and there is a draw-off pipe E^2 and spraying washers E^3, E^4, and E^5 for convenience in cleansing the tank and pipe when the drawing off has been effected. The effluent escapes through the vent H at the lower edge of the effluent baffle H^1 and flows over the sill H^2 into the trap box H^3, passing thence through the syphon J into a second trap box J^1 and away for further treatment by the pipe J^2. The overflow lip H^2 is serrated as shown to an enlarged scale in the left-hand bottom corner of the illustration, and the same formation is given to the lower edge of the septum at G in order, in the one case, to facilitate the final discharge of gases adhering to or enveloping any particles of sludge which may be carried along with the effluent, and, in the other case, to ensure the even distribution of the flow of sewage from the part D to the part E of the tank and to prevent the formation of one or more gutter-ways, which would afford

a short circuit from the vent G to the vent H. With the object of aerating as much as possible the light sludge particles and matters in pseudo solution which unavoidably flow away with the effluent, the inventor introduces a pressure air supply pipe K in the outlet leg of the syphon J.

Of the fittings at the top of the tank L and L¹ are manholes; M is a gas draw-off neck, which is furnished with a cap M¹—which is weighted and acts as a safety valve—and a valve M², and from which a branch is also taken to the heater N. The heater is therefore heated by burning the gas given off by the sewage in the tank, and its special duty is, by means of the heater coils N¹, to maintain the temperature of the liquid in the tank at a sufficiently high point to encourage the required bacterial activity. We understand that the inventor recommends that the temperature should not be less than 70 deg. Fah. In another place he suggests that steam may be allowed to issue through holes in the heater pipes and pass up through the liquid in the tank, thus heating it; but it is difficult to reconcile this suggestion with the stipulation that the sludge should be as little disturbed as possible. The heater may also be used to supply steam which may be utilised in an injector or similar apparatus to force air into the aerator B through the pipe B¹.

With regard to the aerator, the inventor does not claim any particular form, but says that it may be of any convenient type, so long as it is designed to introduce into the sewage a "regulated proportion of atmospheric air for the purpose of promoting and supporting aerobic bacterial processes in the tank." It is explained, however, that the proportion of air introduced into the sewage in the aerating device must be limited so that it does not exceed that quantity which would so dilute the gases evolved from the sewage so as to bring the mixture within "the combustible range." Up to that point, however, it is desirable that the sewage should be "as freely aerated as possible in order to suppress anaerobic conditions in the tank."

One of the distinguishing features of the plant is the non-return air valve O, which is ordinarily kept closed by a weighted lever or spring. This valve comes into action when the engine sucks, and an equilibrium of pressure between the inside and the outside of the tank is established. Moreover, the incoming air serves, according to the inventor, to "stir up and mix the inert components of the gas," as already explained.

It is proposed that the flowing sewage shall suffer a detention of, say, from two to six hours only in the tank, whilst the sludge would be allowed to accumulate until the sludge pit becomes fully charged, a process which, it is estimated, would usually take several months. The sewage slowly flowing from G to H across the top of the sludge lightly disturbs the top of the latter without agitating the mass of it and so "promotes the liberation of gas attached to or entrained in the upper strata of sludge particles, and so said gas is further discharged from the sludge." Under such conditions of working as have been outlined above the surface of the liquid in the chamber D will, the inventor asserts, practically remain exposed, only "a filmy discontinuous scum" forming on it. There is, therefore, no serious opposition to the free egress of the gas. The scum on the surface of the liquid in the chamber E "will also be limited and will be a minimum when the aeration of the sewage is controlled so that the sewage still contains some free oxygen when it leaves the vent H."

In Fig. 2 is given a section through a two-storied tank arranged to work in accordance with the invention. As similar letters have been used in it to designate parts which correspond to similar parts in Fig. 1, no separate description is necessary.

Discussing his invention as a whole, the inventor lays stress on the fact that the flow of the incoming sewage is first of all downwards, and he asserts that in all other treatment tanks that he knows the flow is substantially horizontal or upwards. He emphasises, too, the assertion that "the maintenance of aerobic conditions within the tank is found to promote in a substantial measure the evolution of combustible gases and to procure rapid and effectual purification of the sewage without producing excessive volumes of sludge or objectionable thickness of scum." This system of process and apparatus is therefore double purposed, in that it aims both at the purification of the sewage and at the production from the sewage of a large volume of combustible gas, which gas can either be used as a source of light, power or heat. In addition to the foregoing it is claimed that the effluent from tanks of the Walshaw design is in a better condition for treatment by subsequent processes than is the effluent from any other type of tank. That is, of course, a sweeping claim, concerning which we have not before us, at the moment, any corroborative evidence.

Before going on, as we propose to do in a second article, to discuss what has actually been done both in Australia and in this country in the way of producing gas by this process, we would draw attention to Fig. 3, which illustrates a Walshaw tank designed to deal with the sewage from 1000 persons. The sewage, after screening and aeration, is delivered through three nozzles, spaced at equal distances apart, into an annular channel, the circular lip of which is serrated. The liquid flows over the serrated edge into an annulus of larger diameter, which forms part of a circular two-storied sedimentation tank. The solids sink to a digesting chamber at the bottom of the tank, through the passages indicated by the arrows, while the liquids ascend through serrations on the lower edge of the walls of the annulus into another annulus, over the serrated lip of which the liquid falls into an annular effluent channel. The digestion chamber, which is heated by pipes, is covered with an inverted funnel-shaped cap, the stalk of the funnel reaching up to above the surface of the liquid, and it is up through that funnel that the gases generated in the sludge make their way. Air brought by three 1¼in. pipes from a receiving box to which is attached a non-return valve is delivered at three points near the surface of the liquid in the stalk of the funnel, which is, as will be seen, 4ft. in diameter. The top of the tank is, of course, closed in and the gases are withdrawn and delivered into a 3in. gas main by means of a suction fan. The use of a fan is not, we may say, mentioned in the specification of the patent which has been discussed above, so that possibly it is an afterthought; but as to that, as we have no detailed description before us, we are unable to speak with certainty.

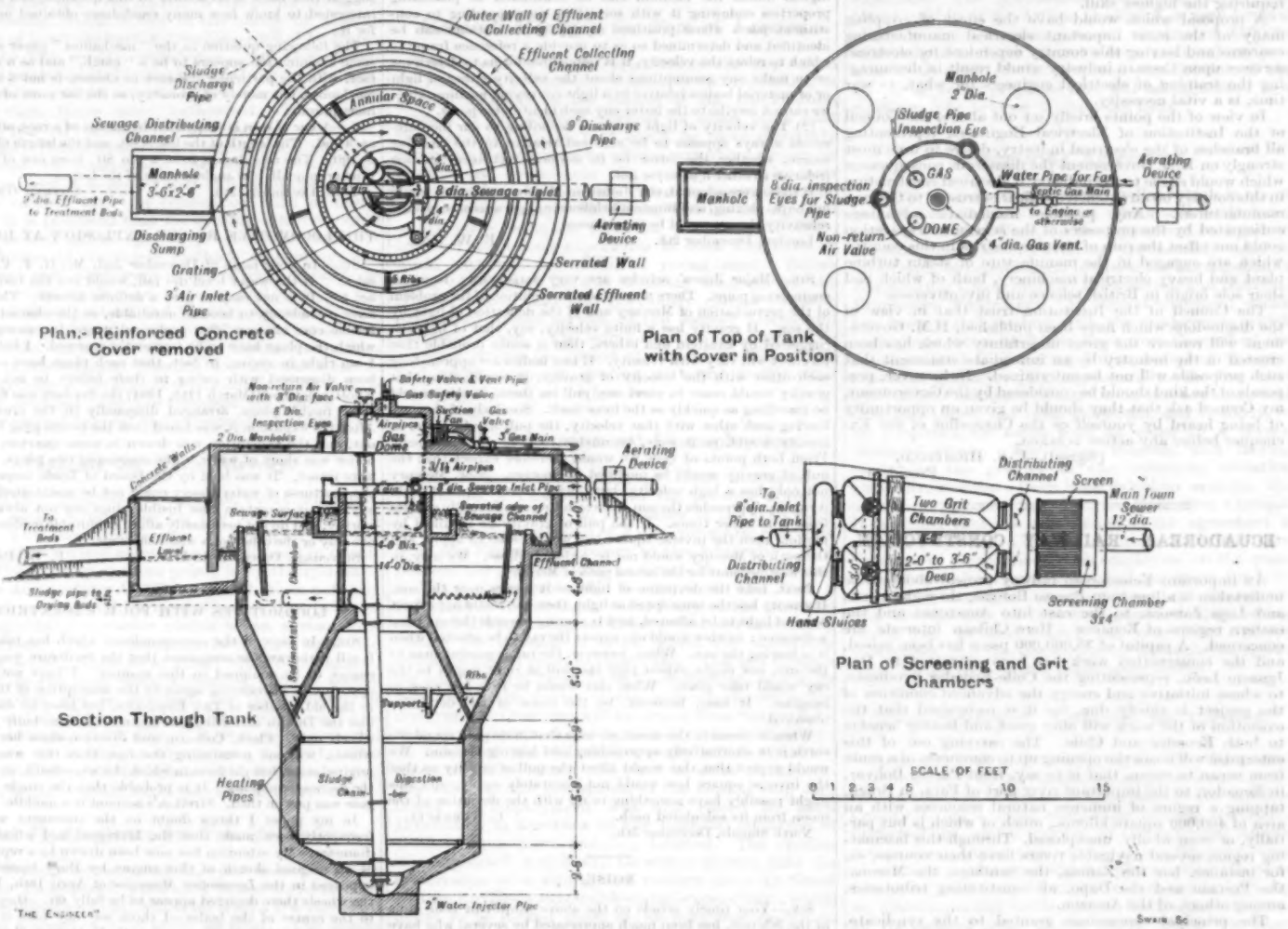


FIG 3—A WALSHAW SEWAGE TREATMENT TANK DESIGNED FOR A POPULATION OF ONE THOUSAND

German Reparations in Kind.

THE following letter has been addressed by the Institution of Electrical Engineers to the Prime Minister:—

SIR,—The Council of the Institution of Electrical Engineers have had their attention directed to certain public declarations and Press communicatiins proposing that the German reparation indemnity should be partly provided by the construction in this country of generating stations and the carrying out of railway electrification by German contractors; and having appointed a Committee to report to them thereon, desire to put before the Government their considered view on these proposals as follows:—

On the general principle of reparations in kind they have to remind the Government that at the present time, when unemployment is so extensive, any reparations in kind should be of such a nature that they do not compete with any productions in this country involving employment on a great scale of labour, both skilled and unskilled.

With regard to the proposals that large electric power stations should be erected and that railway electrication should be undertaken by German contractors, they desire to make the following observations. It is possible that the proposals for the acceptance of German plant on account of reparations may have arisen from a hasty impression that such action would confer benefits on this country in the form of cheaper transport and power. But if such plant is to stand as a contribution towards reparations its value must be debited to the undertakings using it. In no other way can such value be put to the credit of national indebtedness. There is, therefore, no good reason

to suppose that the use of German plant obtained in that way would result in the users of it being able to give a cheaper service than with new equipment of British manufacture.

There are, however, other considerations which my Council desire to urge. The electrical industry in this country is at the present time suffering from a grave lack of employment in all branches, but nevertheless many works are being run in the expectation of a trade revival. Should it be decided to accept German machinery on a large scale, there is no doubt that a large additional amount of unemployment would immediately result, and that both the workpeople and technical staffs at present being kept together would be disbanded. Moreover, the effect of the acceptance for the public service of this country of electrical machinery of German manufacture would be a world-wide advertisement for such goods, and would fatally diminish the present prestige of British electrical goods, with most serious effects on our export markets.

The experiences of the war showed the necessity of this country having a large number of highly skilled and trained electrical engineers available, and the members of the Institution of Electrical Engineers were called upon during the war to undertake work for the national forces requiring the highest skill.

A proposal which would have the effect of crippling many of the most important electrical manufacturing concerns and leaving this country dependent for electrical services upon German industry would result in discouraging the training of electrical engineers for what, in war time, is a vital necessity.

In view of the points briefly set out above, the Council of the Institution of Electrical Engineers, representing all branches of the electrical industry, desire to urge most strongly on H.M. Government the disastrous consequences which would ensue to the industry if electrical construction in this country on an extensive scale is entrusted to German manufacturers. Any possible immediate advantage anticipated by the proposers of the scheme of reparation could not offset the ruin of those industries in this country which are engaged in the manufacture of steam turbine plant and heavy electrical machinery, both of which had their sole origin in British science and inventiveness.

The Council of the Institution trust that in view of the discussions which have been published, H.M. Government will remove the great uncertainty which has been created in the industry by an immediate statement that such proposals will not be entertained. If, however, proposals of the kind should be considered by the Government, my Council ask that they should be given an opportunity of being heard by yourself or the Chancellor of the Exchequer before any action is taken.

(Signed), J. S. HIGHFIELD,
President.

ECUADOREAN RAILWAY CONSTRUCTION.

AN important Ecuadorean railway project about to be undertaken is a line from Puerto Bolivar, through Cuenca and Loja Zamora, to the east into Amazonas and the eastern regions of Ecuador. Here Chilean interests are concerned. A capital of 35,000,000 pesos has been raised, and the construction work has been entrusted to Don Ignacio León, representing the Chile-Ecuador Syndicate, to whose initiative and energy the advanced condition of the project is chiefly due, for it is recognised that the execution of the work will offer great and lasting benefits to both Ecuador and Chile. The carrying out of this enterprise will mean the opening up to commerce of a route from ocean to ocean, that is to say, from Puerto Bolivar, in Ecuador, to the important river port of Pará, in Brazil, tapping a region of immense natural resources with an area of 400,000 square kiloms., much of which is but partially, or even wholly, unexplored. Through this fascinating region several navigable rivers have their courses, as, for instance, has the Zamoa, the Santiago, the Morona, the Postaza and the Dapo, all constituting tributaries, among others, of the Amazon.

The principal concessions granted to ths syndicate, in consideration of the construction of the railway, include right to property over a zone of 20 kiloms. on either side of the line on the alternate lot system between the State and the company, together with the working of the railway and control of the ports for a period of fifty years. Nearly four years were expended in surveying and staking out the line from the coast. The first section of the line will be nearly straight as far as Machala. It will then continue to Santa Rosa, thence to the Torata Pass, where it will ascend the valley of Garanta de Piñas. Thence it will descend in order to cross the Colera, the Amarilla, the Luis and the Embocas rivers, rising to the pass of Santa Ana, whence it will fall to a point 85 miles from the coast. On the second section, the line will ascend to the Toronche Pass and descend to the Catamayo valley, crossing the Guayabál and La Toma rivers. From there it will rise again to the Cajanuma ridge, whence it will descend until it reaches the city of Loja, a distance of 105 miles. The third section will make a considerable curve between Loja and La Toma in order to reach a rich carboniferous area. The line will then cross a fertile and extensive valley between the Malacatos and the Catamayo rivers.

Very heavy engineering work will be required upon a great part of the line, including the construction of eight tunnels within a distance of 5 miles at a point 75 to 80 miles inland. The most important of the tunnels will be that in the Toronche Pass, extending to 1283ft. in length.

THE United States Secretary of the Department of the Interior recently submitted to the President the analysis made by the United States Geological Survey of a comprehensive system for generating and distributing electricity to transport lines and industries in the North Atlantic Coast region between Boston and Washington. The engineers who made the survey, authorised by Congress, reported that 970 miles of 220,000-volt lines and five times that mileage of 110,000-volt lines would be needed. The 1200 miles of wire now carrying 33,000 volts and over would be operated as distribution lines for local industries.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RELATIVITY.

SIR,—In view of the articles now appearing in your columns, would not the suggestion be worthy of consideration for someone competent to work out the consequences and full implications of the two propositions, enunciated below, which, as embodying no more than we are strictly justified in stating in the present state of our knowledge, might be substituted for the two hypotheses upon which Einstein has based his restricted relativity theory ?

Very briefly, Einstein's hypotheses are in effect :—

(1) We cannot possibly detect our motion, if any, relative to the æther.

(2) All observers determine the velocity of light in vacuo relative to themselves to be constant whatever be the uniform rectilinear motion of the emitting source.

I suggest these instead :—

(1) As the concept "velocity relative to a medium" is meaningless unless the medium can be considered as possessing properties endowing it with something corresponding to constituent parts whose positions at any given instants can be identified and determined so as to provide a reference frame to which to relate the velocity, it is impossible for us to determine or to make any assumptions about the velocity either of light or of material bodies relative to a light conveying medium, since we cannot ascribe to the latter any such identifiable parts.

(2) The velocity of light in vacuo according to our measurements always appears to be constant relative to the emitting source, whether the latter be in uniform rectilinear motion (relative to other matter) or not.

If these were adopted, the Michelson-Morley experiment would not be perplexing, and Einstein's elaborate apparatus of restricted relativity theory would be superfluous.

London, December 9th. E. W. HILL.

SIR,—Major Jones' articles are very satisfactory from an engineering point. There may be another solution of the problem of the perturbation of Mercury and of the deflection of light by the sun. If gravity has a finite velocity, say, that of light, as suggested by Einstein and others, then it seems probable that its effect will vary with velocity. If two bodies are approaching each other with the velocity of gravity, it would seem that gravity would cease to exert any pull on them, as they would be travelling as quickly as the force itself. Similarly, if they are leaving each other with that velocity, the pull should cease, as gravity would, as it were, be unable to keep up with them. From both points of view we would therefore expect that the pull of gravity would be modified by motion. Now, Mercury not only has a high velocity, but, owing to its elliptical path, it rapidly approaches the sun at certain times and rapidly recedes from it at other times. If the pull of gravity be modified by motion, then the inverse square law would cease to apply, and the path of Mercury would not be a closed ellipse. We may, in this way, account for the actual path of Mercury.

Next, take the deviation of light as it passes near the sun. If gravity has the same speed as light, then one would not expect a ray of light to be affected, as it is coming towards the sun from a distance ; neither would one expect the ray to be affected when it is leaving the sun. When, however, the ray is passing near to the sun, one might expect that the pull at right angles to the ray would take place. What this would be it is not easy to imagine. It may, however, be the cause of the deflection observed.

When we come to the moon, we note that in its path round the earth it is alternatively approaching and leaving the sun. We would expect that this would affect the pull of gravity so that the inverse square law would not accurately apply, and this might possibly have something to do with the deviation of the moon from its calculated path. C. TURNBULL.

North Shields, December 5th.

NOISE.

SIR,—Your timely article on the above subject in your issue of the 9th inst. has been much appreciated by several who have discussed the matter with me.

Anyone who has listened to a series of witnesses in a noise case in the High Court, attempting to describe the quantity and quality of a noise, must realise how useful a noise meter would be ; but even when the difficult problem of the absolute measurement of any one sound has been accomplished, we shall still be far from having an instrument which will measure the relative annoyance of different sounds (a noise annoyance meter !), for the annoyance by no means varies directly with the loudness. The quality, pitch, mixture, and distance of the source of the noises are important factors in such cases.

Then a noise that annoys one person may not be so objectionable to another. Another well-known and remarkable fact in the case of many people is the ease and rapidity with which they become indifferent to a familiar noise.

You ask whether the noises of a big workshop could be treated as a single note, and then eliminated by the use of the principle of interference. I suggested this in the case of aeroplanes fitted with twin engines, but experience showed it was practically impossible to keep the engines continuously synchronised to produce the desired effect. In the case of the exhaust of an aero-engine we have a fundamental and powerful note which might be dealt with by interference, but the noise of a workshop is the combination of many different notes, producing a very complicated sound wave, and to counteract that by interference would be as difficult as to reduce a military band to silence by the same method. A. S. E. ACKERMANN.

London, S.W. 1, December 13th.

EMPLOYERS' FUND FOR WORKMEN'S CHILDREN.

SIR,—In the interesting article in your current issue on Krupp's works, at the bottom of the second column on page 611, there is a reference to an "unusual" method of payment in vogue at Essen.

It may interest your readers to know that when I was managing an engineering works in the North of France in 1919 the federated engineering employers of Roubaix adopted a scheme under which men with families received a daily allowance for each dependent child, *i.e.*, under sixteen years of age. So that such men should not be penalised by "bad" employers, a fund called "caisse de compensation" (literally "compensation chest") was started, into which each employer paid so much monthly for each man employed—whether married or unmarried—with children or without, and it was from this fund the allowance was paid, any surplus being divided quarterly or a levy made to cover deficiencies if required.

The policy underlying this payment was, of course, to encourage families, so much desired by the more thinking of the French people.

As married men are as a rule more "staid" than unmarried in all countries, it seems as if such a scheme might be introduced with advantage in England ; but I suppose the unions would raise some sort of objection, as they in fact did in the town—not Roubaix—in which my works were situated.

December 13th. A BACHELOR.

A QUESTION AT THE CIVILS' EXAMINATION.

SIR,—Mr. Hovenden's solution can only be admitted if the words "the same" in the question can be taken to mean "similar," and also if the words "at the centre of the first beam" have no significance. It is difficult to accept the statement that two parabolas are *the same as* one parabola double their size. I suggest that there is no answer to this question, and should be interested to know how many candidates obtained any marks for it.

The following question in the "mechanics" paper set at the same examination appears to be a "catch," and as a matter of fact, with the particular dimensions chosen, is not a matter of mechanics, but merely of geometry, as the bar must of necessity hang plumb :—

6.—A bar of iron is suspended by means of a rope attached to each end. The length of the bar is 9ft. and the length of the rope is 10ft. The rope hangs from a pin 8ft. from one of its ends. Find graphically the angle of slope of the bar.

York, December 12th. CONRAD GRIBBLE.

THE LOCOMOTIVE BOILER EXPLOSION AT BUXTON.

SIR,—In your issue of December 2nd, Mr. G. F. C. Gordon asks : "If the water level did fall, would not the fusible plugs act ?" It is not easy to give a definite answer. These plugs have a tendency to become unreliable, as the character of the fusible core changes after prolonged usage, in consequence of which the plugs have to be frequently renewed. I believe that I am right in saying, in fact, that such plugs have sometimes been dispensed with owing to their failure to act. In the Knottingley case (March 11th, 1901) the fire-box was fitted with three fusible plugs, arranged diagonally in the crown plate. After the explosion it was found that the centre plug had given out, and the conclusion was drawn in some quarters that the boiler was short of water. The remaining two plugs, however, were intact. It was held by the Board of Trade inspector that the shortness of water theory could not be maintained ; but in any case it is certain that fusible plugs are not always trustworthy, and do not necessarily afford irrefutable evidence, either one way or the other, of a water shortage.

Stevenage, December 12th. F. W. BREWER.

LOCOMOTIVES WITH FOUR EXCENTRICS.

SIR,—In view of the correspondence which has taken place, I will withdraw the statement that the Swiftsure was the first engine to be equipped in this manner. I have not had the opportunity of referring again to the description of this engine in the old number of THE ENGINEER, but have no doubt that, like the Dublin and Kingston engines, she was built with four wheels only. Clark, Colburn, and Stretton show her with six wheels, without mentioning the fact that this was not her original state, but the form in which she was rebuilt, no doubt by the railway company. It is probable that the single excentric gear was put on then. Stretton's account is a muddle.

In my paper I throw doubt on the statement which has frequently been made that the Liverpool had wheels of 6ft. diameter. My attention has now been drawn to a reproduction of an original sketch of this engine by Bury himself, which appeared in the *Locomotive Magazine* of April 16th, 1917. As the wheels there depicted appear to be fully 6ft.—they come up to the centre of the boiler—I think we may take it that the statement is correct. C. F. DENDY MARSHALL.

Guildford, December 10th.

SIR,—I regret to find that, in my letter published on December 2nd, I gave the reference to the volume of THE ENGINEER as 51 instead of 55.

E. A. FORWARD.

Wembley, December 14th.

HEAVY TENDERS.

SIR,—With reference to Mr. E. C. Poultney's article on the Caledonian Railway's recent locomotives, in your issue of November 4th, allow me to say that there is at least one type of six-wheeled tender in extensive use in England which is somewhat heavier than the one he describes on page 476. I refer to the standard 4000-gallon tenders of the Great Central Railway, which have been used behind all their large 4–4–0, 4–6–0, and 2–8–0 engines built in recent years. This tender weighs, fully loaded, 48 tons 6 cwt.

Mr. Pickersgill's new three-cylinder engines appear to come next in order, with 4500-gallon tenders weighing 48 tons.

I might also mention that the "Glen" class (4–4–0) engines of the North British Railway are provided with 4235-gallon tenders, weighing 46 tons 13½ cwt. in full running order.

WM. T. HOECKER.

Galveston, Texas, November 26th.

A PLAN for heating the dams, valves and gates of power generating plants slightly above freezing point in order to keep them free from ice was outlined before the International Joint Waterways Commission recently in session at Ottawa. Mr. John Murphy, electrical engineer to the Railway Commission, said that in addition to heating the dams and gates, the machinery within the power plant also would be kept at a temperature above freezing point, so as to eliminate any ice formation.

A Seven-Day Journal.

Smoke Abatement Report.

THE somewhat belated final report of Lord Newton's Committee on Smoke and Noxious Vapours Abatement deals with a very wide and complex subject, and it is not surprising to learn that no definite remedy for the prevention of the evil can be suggested. Contrary to general belief, industrial smoke is by no means so important as domestic smoke, although the regulations in connection with it are far more severe, and it is notorious that what is included in the term "industrial smoke" comprises some of the more noxious vapours which are discharged into the atmosphere. It is suggested in the report that the duty of enforcing the law with regard to the pollution of the air by smoke, which is now in the hands of a large number of local sanitary authorities, should be transferred to the county authorities, but that minor authorities should still have power to take proceedings, and the law should enable larger fines to be imposed than those now authorised. Recognising that the present regulations are so varied in character, the report recommends that legislation should be introduced to consolidate the existing statutory provision, and it is hoped that this recommendation will be carried out. In connection with domestic smoke, it is proposed that no housing scheme should be sanctioned unless specific provision is made for the adoption of smokeless methods of heating, and that gas and electricity undertakings should be granted every facility to increase and cheapen the supply of these heating and lighting agents. Special attention is paid in the report to the question of low-temperature carbonisation. The Committee agrees that it is scientifically possible to carbonise coal so as to produce a satisfactory smokeless fuel, but is not yet satisfied that low-temperature plants have been developed beyond the experimental stage.

Lighting the Paris Airway.

EXCELLENT progress is being made with the installation of aerial lighthouses on the London-Paris air route. Two cone lights, one at Lympne and the other at the Croydon air station, are already in operation. The lighting at these points is by the system of the Gas Accumulator Company, which gives not only powerful vertical and horizontal beams, but lights of a distinguishing character visible to an airman over many miles. The foundations have just been laid of a new aerial lighthouse at Titsey Hill, Woldingham, and within the next week a flashing light of 65,000 candle-power will be available for the guidance of airmen and should be visible under normal conditions over a distance of 32 miles. A still more powerful light is to be erected at Cranbrook, in Kent. The intention is, when all the lights on the route have been erected, to put regular night services in operation.

Naval Hydroplanes for Foreign Powers.

THE French Government has just taken delivery from the Thornycroft yard of a motor torpedo-boat of the hydroplane type, which on trial a few days ago attained a speed of 41.6 knots an hour. The design adopted for vessels of this class is, it is interesting to recall, the result of research work which was carried out by Sir John Thornycroft a generation ago. The first boats of this type which were built were the C.M.B.'s ordered by the Admiralty and during the war period considerably over a hundred were put in service. The boat which has been delivered to the French Government is the second acquired by the French navy, and although she is a comparatively small vessel—55ft. long with a beam of 11ft. and a draught of 3ft. 3in.—she is able to mount four machine-guns and to carry two 18in. torpedoes, as well as depth charges. Two similar vessels are being built at the Thornycroft yard on the Thames for the United States navy. It is a somewhat remarkable departure for the American Government to place orders abroad for vessels of the warship class.

Surprising Trade Union Manifesto.

AT a time when all those who have the future of the country at heart are engaged in attempts to promote harmony in the industrial world, the new General Council of the Trades Union Congress has elected to issue a manifesto calculated to bring about the opposite result. It is stated that as a result of the inquiry made the Council has no doubt about the existence of a widespread and carefully organised conspiracy to secure unreasonable reductions in wages and a drastic extension of the normal working week. It is denied that trade improves in proportion to savings on the wages bill on the ground that a lower standard of living for the worker decreases efficiency and creates discontent, with detrimental effects on industry. Low wages, it is asserted, are neutralised by price-cutting competition, and in spite of a reduction during the present year of £286,000,000 in the wages bill there has been no appreciable gain in the prosperity of industry. The manifesto carefully refrains from making any reference to the question of output in relation to wages, but prefers to assert in the name of organised labour, that even if employers could prove that reduced wages and increased hours would lead to industrial prosperity the Council would still be opposed to the suggestion that the workers' standard of life should be lowered to secure that object. The main contention appears to turn on the assumed moral right of labour to an improvement in working conditions irrespective of economic conditions.

General Manager for Port of London.

THERE will be general approval of the step taken by the Port of London Authority in appointing a general manager in the person of Mr. David John Owen. It has seemed obvious for some years past that the work of the port could be more efficiently carried on if there were an official occupying a supreme position to co-ordinate the work of the various departments which it has been necessary for the Authority to set up. Mr. Owen, who has for a period of six years occupied a similar position at Belfast, has had a life-long experience in dock and harbour work, although he is still a young man. Before going to Belfast, he was assistant manager at the port of Goole, and had previously gained valuable experience in the service of the Mersey Docks and Harbour Board. The administrative gifts which he revealed during his period of control at Belfast will find ample scope in dealing with the multifarious interests of the Port of London.

Naval Agreement and Unemployment.

THE remonstrances made by those interested in the future of Chatham as to the possible effect of the naval agreement on the future of the dockyards have drawn a statement of a non-committal character from the Financial Secretary to the Admiralty. It is pointed out that as long as Great Britain possesses a Navy dockyards will be required, and that a reduction in the strength of the Navy or the cessation of the building of capital ships would not necessarily reduce the amount of work which the dockyards would be called upon to undertake. This is a forecast for which it is difficult to find justification, and more hope as to the future of the men employed in the dockyard at Chatham will be drawn from the promise that in the event of a reduction of work at that port on behalf of the Admiralty, every effort would be made to utilise labour and plant at other dockyards. The effect of the suspension of the capital ship contracts on employment was also raised by Lord Invernairn in a review of the financial situation of William Beardmore and Co., Limited. The opinion was expressed, and it will be widely shared, that the importance of a strong and modern navy to Great Britain justifies a reasonable annual expenditure, which ought to be looked upon as an insurance premium. Lord Invernairn does not desire—nobody desires—to see a continuance of the exhausting policy of competition in naval armaments between nations, but even the rigid economist could, he argues, find items of greater amount in the Imperial administration expenses than that set aside for the Navy which call for closer examination as to their value to the country. The opinion gathers force that the action taken in suspending work on the capital ships was probably unnecessary, and in any case having regard to the state of employment far too precipitate.

German Floating Dock for Southampton.

ALTHOUGH nothing definite has yet been settled, it is not unlikely that the offer of the London and South-Western Railway, the owners of Southampton docks, to purchase from the Government the large floating dock which Germany is to surrender to Great Britain will be accepted. The dock, which is one of the largest which has ever been built, is now at Hamburg, where it was recently used for docking the White Star liner Majestic, and if it were moored in Southampton Water would constitute a material addition to the dry-docking facilities at Southampton, on which most of the mammoth liners engaged in the North Atlantic trade will in future be based. The only graving dock at Southampton capable of accommodating these vessels is the Trafalgar, adjacent to which Harland and Wolff, Limited, have established their important ship-repairing shops.

More Technical Societies.

OF the formation of technical institutions there appears to be no end. The latest addition to the number if the provisional committee succeeds in the work entrusted to it will be an Institution of Chemical Engineers. At the preliminary meeting held a few days ago the question whether any of the Institutions already in existence might do the work it was proposed should be done by the new Institution was discussed, and it was unanimously agreed that no other Institution was in a position to undertake it. This decision will surprise those who believe that the number of institutions is already too great, and who recall the fact that previous attempts to form an Institution of Chemical Engineers—made, it is true, many years ago—met with no success. It seems likely, however, that the Institution will now come into existence. The provisional committee, under the chairmanship of Sir Arthur Duckham, is very hopeful of success, and donations to an amount of £500 to meet expenses have already been received or promised. A draft of the proposed constitution of the society is being prepared and will be submitted to a meeting to be held on Wednesday next.

Engineering Agreement.

MUCH interest centres in the ballot which is about to be taken, and the result of which will be declared early in the New Year, on the agreement on freedom of management and on overtime provisionally reached as a result of negotiations between the Amalgamated Engineering Union and the Engineering and National Employers' Federation. An official statement which has been issued dealing with the conferences which took place states that the Executive Council of the Amalgamated Engineering Union accepted the proposals of employers, having regard to the fact that over 90,000 members of the Union are workless, and that the Union has been subjected, and is likely to be subjected, for some time to come to a severe financial strain. For these reasons, and having regard to the gravity of the industrial situation generally, members have been asked to endorse the agreement entered into by the Executive Council. It is added that the acceptance of the agreement is regarded by the Council as imperative, the continuance of negotiations with employers on the questions of machines, apprentices and payment for holidays being contingent on acceptance of the agreement. The membership of the Amalgamated Engineering Union has declined during the year from 460,000 to 430,000, and the percentage of unemployed represents 26 per cent. of the total membership.

Joint Electricity Authority for London.

APPROVAL has now been given by the Electricity Commissioners to the establishment of a Joint Authority on the lines of the proposals made by the London County Council, local authorities owning electricity undertakings, and a number of the principal supply companies. Under this scheme a progressive closing of existing stations would take place during the next few years, and supplies of current taken in bulk by an interconnecting cable system from other stations. In the second stage of the work, which has been modified by the Electricity Commissioners, a large riverside station, with a capacity of about 200,000 kilowatts, would be built to reinforce the supply from the group stations retained during the earlier stage of development. The first of the big new capital stations to be sanctioned would be the 100,000-kilowatt station at Barking of the County of London Company, but the Joint Authority would have power to acquire this station on terms to be prescribed. These are the main features of an important scheme.

Air Mails.

IN the midst of a chorus of criticism of Post Office methods, it is a pleasant task to give a word of praise to the successful attempt to develop the transmission of postal matter by air mail. It is satisfactory to learn, too, that there has been a steady increase in the patronage of the public, particularly in the use of the Cairo–Bagdad air mail service, and it has now been decided to reduce the mail fee from 1s. to 6d. per ounce, as from yesterday. The average time of transmission by ordinary mail between London and Bagdad is twenty-seven days, whereas air mails dispatched from London to Cairo by ordinary mail and thence by air transmission have during the past two months reached Bagdad on the average in twelve days, and on several occasions in ten days or less. The mail which left yesterday is due at Port Said on December 21st, and will be forwarded by air from Cairo on the following day. It should reach Bagdad on or about December 23rd, so that letters for Bagdad and places near will in that case be delivered on Christmas Day. This hope may possibly not be realised, as this is the season of contrary winds in Mesopotamia, and the arrival of the air mail may be delayed.

RAILWAY CONTAINER CARS

(*For description see opposite page*)

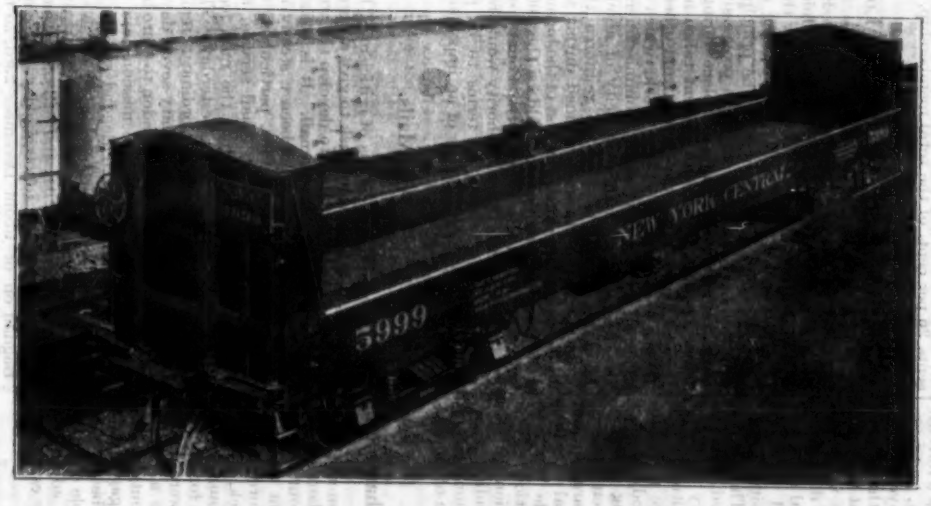


FIG. 1—EXPRESS-TYPE CONTAINER CAR, WITH CONTAINERS REMOVED

FIG. 2—EXPRESS-TYPE CONTAINER CAR, WITH CONTAINERS IN PLACE

FIG. 3—FREIGHT-TYPE CONTAINER CAR, WITH CONTAINERS REMOVED

FIG. 4—FREIGHT-TYPE CONTAINER CAR, WITH CONTAINERS IN PLACE

The Container Railway Car.

By the courtesy of the American Society of Mechanical Engineers we are enabled to reproduce below a copy of a paper entitled "Avoidable Waste in Car Operation—The Container Car," which was read on the 6th inst. before a meeting of that body by Mr. Walter C. Sanders, of the

FIG. 5 MOTOR TRUCKS LOADED WITH CONTAINERS AT CHICAGO POST OFFICE

Equipment Engineering Department of the New York Central lines :—

The container car was an outcome of the railroad congestion during the war and was first put into operation last year by Mr. A. H. Smith, president of the New York Central lines, to reduce the transportation losses due to congestion, which tied up industry. This congestion was caused by the railroads being unable to get rolling stock near the platforms or places where cars could be unloaded and reloaded and put back into circulation. In some cases manufacturing plants used box cars as a storage warehouse, gladly paying the demurrage charged by the railroads. It is hoped that mail, express and freight robberies, breakage, checking and re-handling, delays to shippers, and many other railroad evils may also be materially reduced by the container-car system.

Loss of and damage to freight has grown in recent years into one of the heaviest leaks in the transportation industry, and strenuous campaigns which included maintenance of extensive police and supervisory forces, together with educational campaigns among shippers and railroad employees to secure stronger packing, careful handling and suppression of theft, have failed to stop this economic waste.

The proportions of this transportation problem may be judged from the fact that in the year 1914 American railroads paid out 33,000,000 dols. in claims for loss of and damage to freight, and for the year 1920 this mounted to a total of 125,000,000 dols., the incidental injury to business affected being considerably greater. Under the ordinary system of handling less-than-carload lots or shipments the goods are checked and handled item by item from shipper to truck or dray, from truck to depôt platform or warehouse, and from the platform to the car. They are subject to handling and checking at each stage of the journey, and when finally they reach their destination this handling and checking is all done over again. It is therefore necessary to maintain armies of employees to act as freight handlers, clerks, checkers, and station overseers, as well as switchmen to shunt cars to fixed locations where loading and unloading are possible.

The container system provides that the portable container shall be loaded and locked at the shipper's own store door, conveyed by motor truck to the railroad yard, and lifted by crane aboard the container car, where steel bulkheads and sides form absolute protection against opening the container in transit. At the destination the locked container is unloaded by a crane and carried by motor truck directly to the warehouse or consignee's door, to be unloaded at his convenience. This simple system of handling goods will make it possible to greatly reduce the force of employees now necessary.

Another advantage of the container-car system expected to prove most valuable is the greatly increased use of container rolling stock in moving service, which is particularly important when traffic expands to its "peak" and the prime need is to shorten layovers of cars in yards and stations for loading and unloading, and to limit their idleness and obstruction through misuse for storage purposes. In busy times the need is to keep every wheel turning as continuously as possible to secure maximum transportation. With ample supplies of the removable containers, which in their several classes are of uniform size and interchangeable, one carload of containers may be removed and sent with their loads to consignees, and another set immediately hoisted into place and the car be ready to proceed within a matter of minutes in most instances. The locked containers may remain on station platforms or at the stores of shippers for loading or unloading at convenience without tying up costly rolling stock at points where track capacity is limited and congestion quickly obstructs the flow of traffic unless the cars are kept moving. With this rapid handling of the containers on and off the car the mileage per year made by the ordinary piece of rolling stock may be doubled, and it is predicted that the tremendous expense of maintaining box cars and other rolling stock equal to all emergencies will be materially cut down.

The container car may make costly packing and crating unnecessary, because goods packed in flimsy pasteboard boxes or even bound with heavy paper are protected against breakage, theft, and water or weather damage.

There are at present in service on the New York Central lines three container cars, one of the mail or express type and two that are being used for valuable freight, such as silks and woollens. Three new mail cars of improved design which are now being constructed will be equipped with an improved type of all-steel container. A new freight type container car is being designed, and refrigerator and tank container cars are contemplated.

General Description of the Container Car.

The container car is nothing more than a long car with a steel side or fence, similar to a low-side gondola, loaded with large steel safes or containers, made as light as possible, in which commodities of all kinds travel from consignor to consignee, inviolate against thieves, fire, weather and breakage. The safes or containers are lifted on and off the car by cranes or hoisting devices, permitting the "parent" rolling stock to continue in immediate transportation circulation. In appearance the loaded car seems to be a solid load of safes or steel vaults set aboard a steel underframe with a low protecting steel fence.

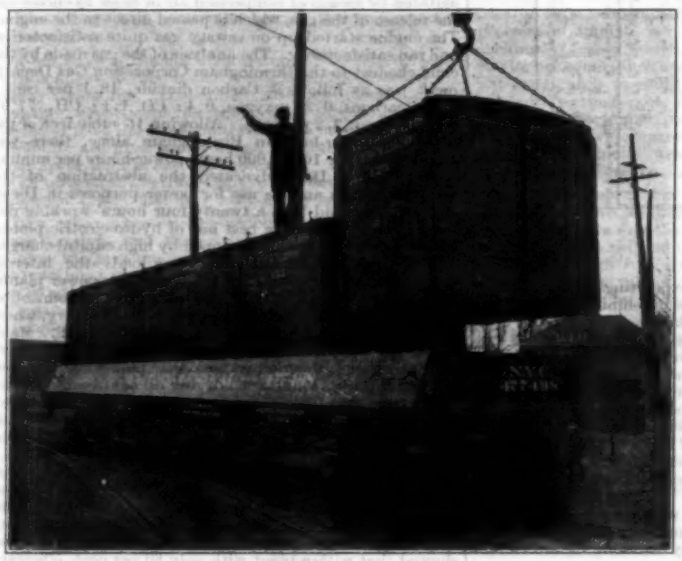


FIG. 6—UNLOADING A CONTAINER FROM A FREIGHT-TYPE CONTAINER CAR

FIG. 7 FREIGHT-TYPE CONTAINER ON A MOTOR LORRY

Express Container Cars.

The present express car now in use is 61ft. 3in. in length, with trucks and fittings that make it interchangeable with standard passenger equipment for use in any passenger train. All modern safety appliances for a special type of car are installed, such as air brakes, hand-hold irons, sill steps, &c. This car carries nine containers, each 9ft. wide by 6ft. long, with an inside clear height of 7ft. 4in. and a door 3ft. by 6ft. The containers are as nearly burglar, fire, and weather-proof as it is possible to make them, with a carrying capacity up to 7000 lb. They have wood floors and are arranged with four eyelets or hooks, one at each top outside corner, for convenient lifting and handling. The doors are of standard refrigerator design

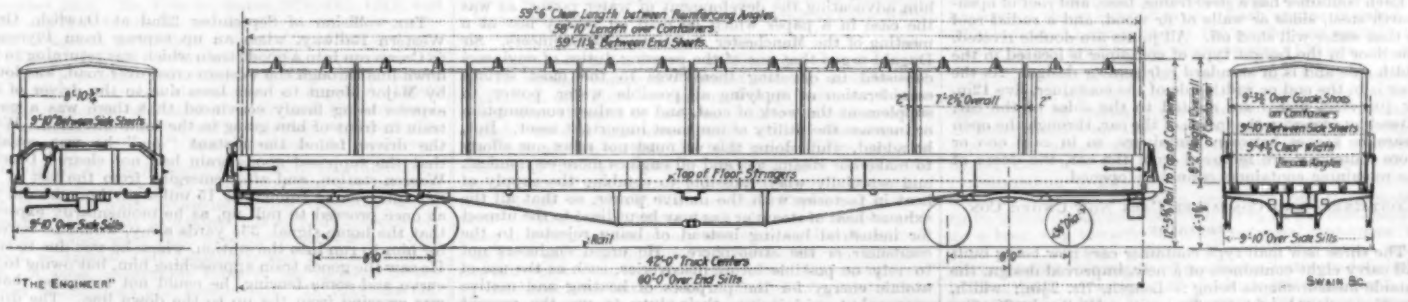


FIG. 8—GENERAL ARRANGEMENT OF IMPROVED TYPE OF MAIL CONTAINER CAR

and are arranged with a hasp and staple for the shipper's padlock, also with pin and slot for standard freight car seal.

The steel sides of the car are spaced to suit the width of the containers, with a clearance of ½in. on each side; the containers cannot be made as wide as the car itself because of the various State highway laws which regulate the width of motor trucks. The New York State law, for instance, limits the width of an auto truck, including body, to 8ft., the height from road to top of truck or lading to 12ft. 6in., and the truck and lading must not have a combined weight over 25,000 lb. All container cars are fitted with bulkheads and steel sides 2ft. high, into which the containers fit.

In the interior of the body of the gondola part of the car are sectional guides, made of ¼in. steel, resembling channel steel, with the laps projecting out from the open ends to enable them to be riveted to the sides of the car. There are guides at each place on the side of the car where the corner of a container will lie.

At each corner on the length side of each container there is a shoe, also of pressed steel, which will fit into the socket formed by the two guides. This arrangement guides the containers to the floor of the car and holds them in place while the car is in transit, without additional blocking or fastening. If it is found necessary to move the car over the road after one or more containers have been removed, it is unnecessary to put in any kind of blocking, because these guides and shoes are arranged to hold the containers and prevent them from shifting or falling over because of the oscillation of the car.

Freight Container Cars.

The two freight type container cars are 50ft. long. This is exceptionally long for a car used in freight service, being 9ft. longer than the longest of New York Central box cars. The general construction is similar to that of the express type container car.

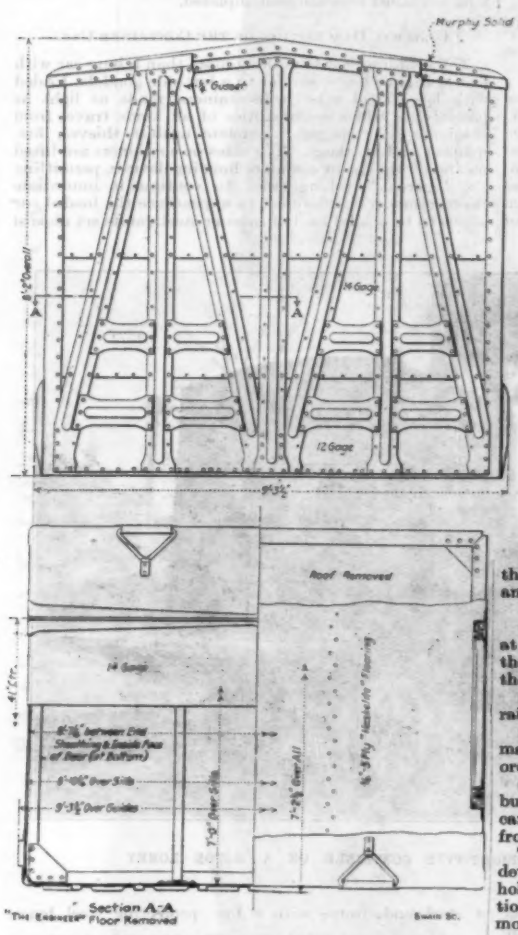


FIG. 9—IMPROVED TYPE OF MAIL CONTAINER

The freight type carries six containers, length 6ft. 7in., width 7ft. 1½in., and clear height 7ft. 7¾in., all inside measurements.

Each container has a steel frame, base, and roof of open-hearth steel, sides or walls of fir wood, and a radial roof so that water will shed off. All joints are double riveted. The door in the freight type of container is located in the width side and is of standard refrigerator design. As the door is in the end or width side of the container, five 12in. by ¼in. steel plates are riveted to the sides of the car, extending crosswise the inside of the car, through the open clearance spaces between containers, so in case one or more containers are removed from the car, the doors of the remaining containers cannot be opened.

Containers and Container Cars Now Under Construction.

The three new mail type container cars now being built will carry eight containers of a new, improved design, the outside measurements being:—Length, 7ft. 2¼in.; width, 9ft. 3½in.; clear height, 8ft. 2in.; with a 5ft. 9in. by 2ft. 6in. door on the length side of the container. The cubic capacity will be 438ft., light weight 3000 lb., and capacity 7000 lb.

Tests conducted in the last few months on the New York Central lines have demonstrated that the express type of container car can be emptied of the nine containers by an ordinary crane in twenty-one minutes and reloaded with other containers and the car put back in circulation in about the same time. This test was made with an ordinary moving track crane, since no special cranes or handling devices have as yet been constructed for use in handling the containers. With the special handling devices contemplated it will be possible to unload the containers with greater speed directly to waiting motor trucks, platforms, or on the ground.

During May, 1921, at the request of the Postmaster-General, a mail test was run from New York City to Chicago, Ill., and return with the express type of container car. Upon arrival at Chicago the nine containers, containing 37,000 lb. of mail, were unloaded on to waiting Post Office motor trucks in twenty-one minutes, which is one-fifth of the time used in unloading an ordinary mail storage car. At Chicago connections were made with western mail trains that have never been made before. Upon the arrival of the car at New York on the return trip the containers were removed from the car in eighteen minutes.

It is believed that the use of containers in mail service (1) will prevent the loss in transit of valuable registered mail, parcels post and other mail; (2) will mean a saving to the Government in handling mail, both in trucking and checking, as well as a material saving to the railroads in the use of equipment; (3) will make possible a quick transfer at important gateway points and the maintaining of close railway connections otherwise impossible; and (4) will afford an increased weight and capacity as compared with the average load now handled in mail storage or baggage cars, the average weight of mail now carried in mail storage cars being approximately 30,000 lb.; 37,000 lb. of mail were carried on the run to Chicago.

Summary.

A summary of the prime advantages of the container-car system is as follows:—

(*a*) It will furnish a means of expediting delivery of less-than-carload lots of commodities by eliminating the time and expense of re-handling, checking and trucking.

(*b*) It will eliminate costly crating and packing.

(*c*) The immediate unloading and loading of containers at terminal points eliminates the item of demurrage, at the same time promptly releasing rolling stock, clearing the yards of cars, and reducing congestion.

(*d*) It will eliminate the piecemeal loading of cars at railway sidings in exposure to all kinds of weather.

(*e*) It will tend to keep the car moving at all times, making possible double the mileage as made now by an ordinary piece of rolling stock.

(*f*) Containers are fire and weather-proof, and also burglar-proof, in that they cannot be opened while on the car or while being transferred by handling device to and from the car.

The increased service capacity of each unit by the development of the container car system is thought to hold far-reaching economic possibilities in railroad operation of the future, as well as in the co-ordinated use of the motor truck and the electric railway.

Water Power.

Sir Dugald Clerk's name is so intimately associated with the internal combustion engine that it came as something of a surprise to a Manchester audience to hear him advocating the development of water power, as was the case in a paper which he read on Friday last at a meeting of the Manchester Association of Engineers. Sir Dugald urged that one of the pressing duties of engineers consisted in devoting themselves to the most serious consideration of applying all possible water power to supplement the work of coal, and so reduce consumption or increase the utility of our most important asset. But, he added, while doing this we must not relax our efforts to make our steam, gas and oil engines more economical, and especially where possible to combine the supply of heat in factories with the motive power, so that all the exhaust heat of steam or gas may be utilised to the utmost for industrial heating instead of being rejected to the condenser or the atmosphere. He urged engineers not to rely on possible future discoveries, such as the use of atomic energy for the purposes of heating and motive power, but said it was their duty to use the present knowledge to the best advantage for mankind. In this connection reference was made by the author to Lord Kelvin's proposal to generate large quantities of low-temperature heat such as is necessary for the warming of buildings by the adoption of a reversed Carnot cycle. He admitted that Lord Kelvin's conclusions looked as if they were wrong, but they were really perfectly correct, the difficulties of application being practical and not theoretical. Those practical difficulties could, he thought, be overcome. Quoting from Professor A. H. Gibson's table of the world's water power, Sir Dugald pointed out that when coal fails us we should not be by any means at the end of our energy resources. We could still supply nearly double the amount of energy at present in use as motive power, and we could even contrive to keep our houses warm by the use of the ingenious proposal of Lord Kelvin. For other fuel purposes, such as furnace work and metallurgical reduction, we should have recourse to charcoal prepared from wood, and engineers would enter a period similar to that before 1750, when we depended on our forests for the means not only of building our ships, but smelting iron. Ships and railways would then be driven by gas producers using charcoal, and our factories would be driven mainly by hydraulic power. Fascinating problems, such as power storage to translate the effective twenty-four hours' horse-power to the larger rate of eight hours per day will enable the possible one and a-half million of water power to give something approaching four millions during the shorter period.

The discussion which followed the reading of the paper developed over a very wide field. Mathematics, science, economics and even politics were all brought into the debate by various speakers. Mr. H. Pilling, the chairman, in the absence of the President, Mr. F. West, referred to the great waste of fuel which was tolerated for processes and for power purposes, and advocated the employment of Government inspectors to visit works and report cases of waste of coal. He would even go so far as to put the person responsible for waste on rations. With regard to the adoption of large hydraulic power schemes, he regretted that hydraulic engineers capable of carrying out such schemes were not available in this country. Mr. H. Bickerton said that one of the difficulties usually met with in the application of hydraulic power was that the source was generally in the wrong place and the cost of transmission was too great to make its use a commercial proposition. He advocated the employment of sewage gas for power purposes, and referred to a pumping installation at the Cole Hall sewage works of the Birmingham Tame and Rea Drainage Board.* The installation consisted of a 34 brake horse-power National gas engine, which operates a 5in. centrifugal pump together with other machinery of a total average load of 25 horse-power. Mr. Bickerton said the only addition to the plant which was installed for the treatment of the sewage was a closed concrete tank 14ft. long by 10ft. wide by 4ft. deep at one end, and 8ft. deep at the other. The sewage is pumped into this tank and filled to within about 2ft. of the top. It is agitated by means of compressed air in order to encourage the release of the gas, which is passed direct to the engine. The engine started up on sewage gas quite satisfactorily, and ran satisfactorily. The analysis of the gas made by the chief chemist to the Birmingham Corporation Gas Department was as follows:—Carbon dioxide, 18.1 per cent.; hydro-carbons, 0.2; oxygen, 0.4; CO, 1.1; CH_4, 77.0; and nitrogen, 3.2 per cent. Allowing 16 cubic feet of gas per horse-power-hour in Birmingham alone, there was available gas for 16,000,000 horse-power-hours per annum.

Mr. Charles Day advocated the abstraction of the oil from sewage and its use for power purposes in Diesel engines. He said that a twenty-four hours' working day was essential to get the best out of hydro-electric plants, which were generally handicapped by high capital charges, and he urged that for short hour loads the internal combustion engine was cheaper than water-power plants. Mr. C. Bentham alluded to the difficulties in connection with the use of hydro-electric power in this country, where the amount of water falling was relatively small. Many difficulties had been encountered during the past summer in connection with small water-power plants driving flour and other mills owing to the drying up of streams, and an alternative supply of power was necessary in such cases. If all the water power available in this country was made use of it would only amount to about 2½ per cent. of the total requirements.

Mr. Julius Frith advocated the employment of waste heat schemes in connection with large steam power stations, as was carried out in Manchester. He described the use of the reversed Carnot cycle as "pumping heat out of the universe into a room," and by means of calculations showed that with a plant with only 80 per cent. efficiency Lord Kelvin's idea still left an ample margin of heat compared to the power used. Dr. Morley also spoke on the reversed Carnot cycle, which he described as a "warming engine." He said the theory was all right, but the difficulty lay in putting it into practice. We were usually concerned with transforming heat into work, but with the reversed Carnot cycle heat is the effect and power the cause. He said the absence of discussion showed the state of knowledge of the problem. With regard to general power supply, he considered that one possible source was the intensive cultivation of rapidly growing plants in tropical regions for the production of oil.

The collision of September 22nd at Dawlish, Great Western Railway, when an up express from Plymouth to Crewe ran into a goods train which was returning to the down line through the western cross-over road, was found by Major Mount to have been due to the driver of the express being firmly convinced that there was a goods train in front of him going in the same direction. When the driver found the distant "on" he was satisfied that the supposed goods train had not cleared Dawlish Warren station, and after emerging from the last of the five intervening tunnels at 15 miles per hour he did not at once proceed to pull up, as he momentarily expected that the home signal, 334 yards away, would be lowered for him to run into the station, where he was due to stop. He saw the goods train approaching him, but owing to the curve and some fencing, he could not recognise that it was crossing from the up to the down line. The driver was a most experienced man with a good record. A matter not mentioned in Major Mount's report, but which is of interest is: How would automatic train control have treated this question? The driver responded to the distant signal and was running at only 15 miles per hour when over 300 yards away, and yet the collision occurred.

* We propose to refer in greater detail to this interesting plant in a future issue, in continuation of an article which will be found on page 642 of to-day's number.—Ed. The E.

Railway Matters.

Sleeping accommodation for first-class passengers has now been restored by the Great Western Company between Paddington and South Wales and *vice versâ*.

The South African Railways and Harbours Board has now definitely decided on the electrification of 171 miles of railway from Glencoe to Pietermaritzburg.

From the 5th instant the train service between Liverpool-street and Ealing by the Ealing and Shepherd's Bush railway has been expedited during the busy hours.

The Central Wages Board having failed, on Tuesday, the 13th inst., to agree as to the wages and hours of duty of the Scottish railwaymen, the matter will now have to go to the National Wages Board.

The Railway Amalgamation Tribunal will hold a public inquiry at 7, Whitehall-gardens, on Tuesday next to consider the preliminary scheme for the amalgamation of the London and North-Western and Lancashire and Yorkshire Railway.

A baronetcy has been conferred upon Sir Francis Dunnell, the secretary and solicitor of the North-Eastern Railway and until lately the head of the secretarial and legal branch of the Ministry of Transport. This is the first time so high an honour has been conferred on a railway officer.

In our Journal page of September 16th we announced that Mr. G. J. Churchward, the chief mechanical engineer of the Great Western, was retiring at the end of the year, and that Mr. C. B. Collett, his deputy, was succeeding him. At a recent meeting of the Great Western board this was confirmed.

It is reported that plans are being worked out for a new railway to extend from Nogales to Port Lobos or some other port on the Gulf of Cala, in Mexico. The line would be approximately 200 miles long, and it would traverse a potentially rich agricultural, cattle and mining region now lacking transportation facilities. A Governmental subsidy is expected.

Some considerable accelerations have, since December 1st, been made in the London, Brighton and South Coast train services. This is an unusual time of the year to make such changes, and for no ostensible reason. It is, therefore, fair to suggest that the fact that the Brighton Company will enter the Southern group on its traffic earning valuation may have had some influence on these unexpected improvements.

In our issue of the 9th instant appeared a letter from a correspondent asking as to the speed orders issued by railway companies. These orders are always issued by the operating department on the request of the engineer. The latter fixes the speed limit, which is never questioned. The limits are fixed more or less arbitrarily and usually much lower than is actually necessary. Their purpose is less to safeguard the train than to prevent disturbing any timber work, &c., that may temporarily have been put in.

On a railway branch line which links up Mantes with Epone-Mezieres and Plaisir-Grignon, an ordinary motor omnibus has been made to take the place of a locomotive. The omnibus has been fitted with special wheels, and may now be seen running across the country with two ordinary railway carriages behind it. The engineer in charge of the experiment expresses himself as quite content with the results, although he considers that still better results should be obtained with a 60 horse-power motor, which will be tried next month.

The driver of the express from Bristol concerned in the fatal collision of the 26th ultimo at Birmingham told Colonel Pringle, at the latter's inquiry on the 1st instant, that the lowering of the fixed signals at No. 5 box was authority for proceeding as far as the signal at the platform box, but not for running through the station. His explanation of why he overran the signal in the station was, however, given *in camera*. Earlier in the inquiry another driver suggested that there should be a repeater for the platform signal further along the platform.

The special with Mr. Lloyd George's secretary, conveying a copy of the Irish agreement for Sir James Craig, which left Euston about 3 o'clock on the morning of Tuesday, the 6th, for Holyhead, did not make the record journey some might expect, considering that it had only one booked stop. This would be due to the fact that the line would at that time be fully occupied with important merchandise trains which could not readily be shunted. There was, it will be remembered, no time to prepare a road for the special, as the agreement was arrived at suddenly.

The general manager of the Great Western Railway, writing in the December issue of that company's magazine, draws attention to the figures in the railway accident returns for 1920, which were summarised in our issue of November 25th. Mr. Pole compares 1920 with 1913, and points out that in the latter year there were 40 servants killed, as against 24 in 1920, a reduction of 40 per cent., and 3335 injured as compared with 2264, a decrease of 32 per cent. It is added that comparing the first six months of the present year with the corresponding period of 1920 shows a reduction of 1 fatal accident and 475 non-fatal. Of the casualties in the first half of this year, 9.21 per cent. were due to want of care; last year it was 13.15 per cent.

According to the accident bulletins of the Inter-State Commerce Commission, 95 passengers and 422 servants were killed in train accidents during the year ended December 31st, 1920, as against 110 and 359 respectively in 1919. There were 4631 passengers and 3385 servant injured, as against 4549 passengers and 2955 servants in 1919. A most remarkable thing is the increase in the number of collisions and derailments. In 1917 the collisions were 7497, 8715 in 1918, 6904 in 1919 and 10,110 in 1920. Of derailments there were 9991 in 1917, 13,568 in 1918, 15,807 in 1919 and 22,477 in 1920. The rules of the Commission say that accidents that do not lead to a certain value in damage need not be reported. With the growing cost of labour and material, accidents formerly non-reportable are now recorded and give an apparent increase. The figures for 1920 are just 50 per cent. higher than in 1919, but we cannot say if the increase is due to the cause just named.

Notes and Memoranda.

In the course of his recent presidential address to the Chemical, Metallurgical and Mining Society of South Africa, Mr. F. Martinweiler said that a subject requiring investigation was the utilisation of the zinc contained in solutions which came from the extract boxes after the precipitation of the gold. At present this zinc goes to waste, and if utilised might prove to be an asset to the industry.

Crawfish, according to the *Engineering News Record*, threatened to destroy a canal bank on the Cape Fear River, by tunnelling into the bank and causing it to leak. Sheet piling did not cure the trouble, as the fish worked round the ends or beneath the piling, so rows of auger holes were made in the bank. The holes were filled with chloride of lime and small sticks of dynamite exploded in them. Other holes were charged in the same way with common salt and the fish were presumably exterminated, as the leaks stopped.

The Blackburn Corporation has in commission an electric locomotive, supplied by the English Electric Company, on the railway siding that runs alongside the new electricity works at Whitebirk. It has a haulage capacity of 80 tons, and has at times drawn as many as eight 10-ton railway trucks. It rendered excellent service during the construction of the new electricity works in conveying the new plant, &c., from the railway sidings to the site. It has been stated by the borough electrical engineer, Mr. P. P. Wheelwright, that considerable economies have undoubtedly been effected by its use.

Discussing the question of technical education for apprentices recently, Mr. A. S. Elston, of the Amalgamated Engineering Union of South Africa, said that while the principle was sound, hundreds more lads were being trained in various branches of engineering in South Africa at the present time than had any prospect of being absorbed by the skilled trades of the Union when they reached the proper age. He thought that it should be pointed out to them that other branches of industry and commerce were equally attractive, and that efforts should be made to spread the youth of the country equally over the various industries.

An unusual type of explosion is described in official report No. 2523. It concerned a cast steel autoclave 3ft. 6in. in diameter by 5ft. high, with a minimum thickness of 3⅛in., which had been tested hydraulically to a pressure of 1200 lb. per square inch. It was used for a chemical process which required a pressure of about 600 lb. per square inch and a temperature of 200 deg. Cent., but burst at a pressure estimated at about 25 lb. An appendix to the report, signed by Dr. Rosenhain, suggest that the failure was possibly due to minor explosions which may have occurred in the autoclave from time to time and gradually weakened the vessel by extending originally small cracks.

In the course of his presidential address before the Birmingham and Midland Institute, Senatore Marconi is reported to have said that much greater progress had been made than was realised in the utilisation of wireless telephony, although he regretted to say that its practical application was taking place chiefly in countries other than England. In Holland, for example, the Amsterdam Stock Exchange transmitted at frequent intervals daily the latest stock prices and other commercial information by wireless telephony, and that was received simultaneously by nearly 200 banks in Holland by means of apparatus constructed by the Marconi Company. In England the only commercial end for which wireless telephony had so far been used was to establish communication between the Bar Lightship in the Irish Channel and the Mersey Dock and Harbour Board in Liverpool. He would be sorry to think that that was the only place in the United Kingdom where a use could be found for wireless telephony.

In the third number of the *Fuel Economy Review* issued by the Federation of British Industries there is an article on the cleaning of fires in boilers with stationary grates, which concludes with the following remarks:—(1) With usual methods of cleaning the wastage of fuel in the ashes may be considerable. This is particularly likely to occur with low-grade fuels containing a high percentage of ash. (2) With low-grade fuels "front and back" cleaning appears to give better results than "side" cleaning. (3) It is bad practice to burn down the fires too completely before cleaning, since this retards the recovery to normal furnace conditions. (4) The use of the baffle bridge appears to offer advantages mainly resulting from (*a*) the larger quantity of fire which can be retained during the cleaning process; (*b*) the more complete "burning down" of the fire which is possible after transferring the live fuel to the bridge; (*c*) the greater ease with which the clinker and ash can be completely removed. These advantages appear to be more marked with low-grade fuels containing a high percentage of ash or with fuels such as coke, which are not readily ignited.

The United States Bureau of Mines has issued a warning to mining companies against storing carbide with explosives, and gives an explanation of recent explosions which were thought to have been due to causes not accidental. In one case investigation showed that two full drums of calcium carbide had been stored in the magazine containing the high explosive, and that there was a newly opened box of the explosive placed alongside of a can of the carbide. Charles F. Munroe, Chief Explosive Chemist, says:—"Acetylene differs from the other combustible gases and vapours commonly met with, in that it not only may form explosive mixtures with air as they do, but that, like nitro-glycerine, it is itself explosive. This was proved by Berthelot, who initiated an explosion wave in acetylene by detonating a charge of mercury fulminate in it in the same way in which he initiated the explosion wave in nitro-glycerine by firing a detonator in it. Fortunately, if the acetylene is under a pressure of less than two atmospheres the explosion wave dies out very promptly. But if the acetylene is under a pressure of more than two atmospheres an explosion wave initiated in it by shock, or other means, is propagated through the whole mass. Most disastrous accidental explosions have been attributed to this characteristic of acetylene."

Miscellanea.

The first number of the *Ebbw Vale Works Magazine*, which has just been issued, is a bright little journal to which a large number of authors have contributed. It is of a social rather than a technical character, but there are some interesting historical notes on the old-established works.

Among other new adaptations of rustless iron which are under consideration, gramophone fittings are regarded as one of considerable importance. No very great enthusiasm for the metal has been aroused in the motor trade at present, but a number of makers have sent out inquiries and are studying its application to bonnets and most of the metal fittings of cars.

A general and international exhibition of agricultural equipment and machines will be held in the Grand Palais on the Champs Elysées at Paris from January 28th to February 5th, 1922. The exhibition is being arranged by the French Ministry of Agriculture with the assistance of various agricultural and other bodies. Further particulars may be obtained by application to Monsieur le Commissaire Général du Salon de la Machine Agricole, 8, Rue Jean-Goujon, Paris, *&c.*

Eleven sites in the Travancore State have been examined with a view to hydro-electric undertakings. As regards the Kallar scheme, the proposal is to construct a masonry dam to impound water in a lake of four square miles, with a fall of nearly 1000ft. The Government of Bengal has appointed an expert committee to carry out a hydro-electric survey of the province. The survey is to be confined in the first instance to the Hill Tippera area round Comilla and Chittagong.

A nine-day exhibition of Malayan-Borneo industries will be held in Singapore on the occasion of the visit of His Royal Highness the Prince of Wales. The exhibition will open on March 31st, 1922, and will include five principal sections, viz., forestry, agriculture, minerals, arts and crafts, and commerce. The last is to be one of the most important, and it is hoped that there will be a representative display of imported British goods, such as motors, machinery, piece goods, foodstuffs, *&c.*

Information recently to hand from Kedah Malay Peninsula, states that a water- supply scheme for the town of Sungei Patani is shortly to be undertaken, the water being brought by pipe line from Kedah Peak. The scheme is capable of extension to other localities in the neighbourhood as opportunity offers. The town of Kulim is also to be supplied with water by pipe line from hills in the neighbourhood. The pipes have been ordered from England, and the construction of the necessary dam is to be started forthwith.

The report of the International Board, which has been considering the question of the improvement of Shanghai harbour, recommends the dredging of a channel, 600ft. long and 30ft. deep, in the south channel of the Yangtze estuary; the elimination of the private ownership of wharves, the entire harbour being placed under the International Harbour Commission; the construction of public quays and moorings and also of a commercial dock of the open type and mail steamer accommodation. In this connection it is proposed to build immediately a 600ft. wharf and 2500ft. of berthing suitably equipped. The estimated expenditure on immediate requirements is 10,750,000 Shanghai taels.

A blast-furnace has been erected by the Onakaka Iron and Steel Company, a company formed in 1920 to manufacture iron and steel from the limonite iron ore found in the Onakaka—Nelson Province—district of New Zealand. Coke, ore and limestone are to be raised to the top of the furnace by hydraulic lift and sixteen beehive coke ovens are being built close by. The company anticipates that the industry will eventually employ some hundreds of men, and that the output of the plant will be 30 tons per day. New Zealand's requirements of foundry iron are said to be in the neighbourhood of 15,000 tons per annum, so that the company will not be able to supply the full requirements of the country.

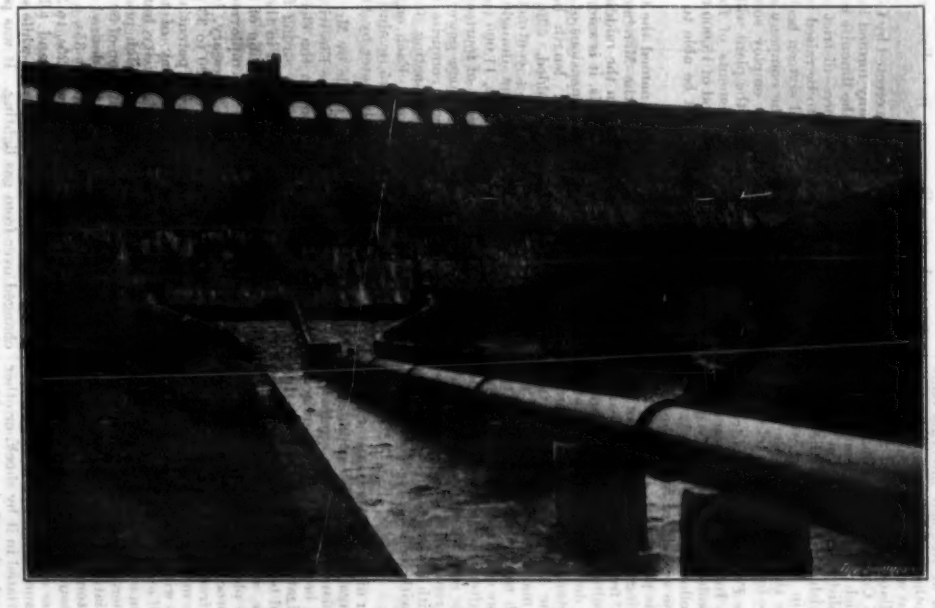
A twin-screw motor ship, named the Californian, was launched from the yard of the Merchant Shipbuilding Corporation at Chester, Pa., in the middle of November. The Missourian, a sister ship, is, it is said, to be launched this month. The principal dimensions of the two vessels are:—Length overall, 461ft.; length between perpendiculars, 445ft.; beam, moulded, 59ft. 8in.; depth, moulded to shelter deck, 39ft.; contract draught, 28ft. 6in.; displacement at contract draught, 16,500 tons; deadweight at contract draught, 11,000 tons. The cargo-handling machinery will consist of fourteen double-geared winches each driven by a 30 horse-power electric motor. The propelling machinery will comprise two Burmeister and Wain six-cylinder single-acting four-cycle Diesel engines of the crosshead type. Each engine is rated at 2250 indicated horse-power at 115 revolutions per minute. The cylinders are 740 mm. diameter by 1150 mm. stroke.

In the course of inquiries made by Mr. Scott Moncrieff in connection with the work of the Electrical Development Association on unemployment in the electrical industry, he ascertained that there was a strong feeling amongst wiring contractors that a reduction in the cost of wiring would result in a material stimulation of business with a corresponding reduction of unemployment. Opinions differed as to the reduction necessary, but it appeared to be generally agreed that from 20 to 33 per cent. would go a long way towards inducing potential customers to have their premises wired. Many of the latter were anxious to obtain a supply of electricity, but were definitely holding back on account of the high prices current. A few contractors held that a reduction of 50 per cent. would be necessary to bring about the desired result. Where the cost of wiring was round about 35s. a point, business was dull, but where the price was 25s. to 30s. a point the contractors were fully occupied, and all new premises were being connected to the mains, while some were being changed over from gas lighting. It was pointed out that the cost of labour was the chief obstacle, and that a fair proportion of the desired reduction should come from that quarter.

THE SCAR HOUSE HYDRO-ELECTRIC INSTALLATION OF THE BRADFORD CORPORATION

MR. LEWIS MITCHELL, M. INST. C.E., BRADFORD, AND VICKERS LIMITED, ENGINEERS

(*For description see page 639*)



DOWN-STREAM FACE OF ANGRAM DAM, AND PIPE LINE

VIEW OF RIVER NIDD AND PIPE LINE, FROM ANGRAM DAM

PIPE LINE AND POWER HOUSE

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By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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THE ENGINEER.

DECEMBER 16, 1921.

Engineers as Administrators.

In his chairman's address to the Junior Institution of Engineers on Friday, December 9th, Mr. Wordingham asked a question which has often vexed the minds of engineers. "Is it right," he inquired, "that a man who has attained a high degree of scientific or technical knowledge should devote his talents and acquirements to purely administrative work?" He, himself, holds that it is right, because he believes that "only a trained scientific mind can properly understand the difficulties of the staff or efficiently direct their activities," and because the inspiration they need can only reach them "through guidance by one of their own kind." Weighty as these reasons are, there are yet many who feel that there is something wrong with a system which takes a man away from that field in which he has by years of study and by the gaining of experience become an adept, and employs him in a vocation where the direct value of his high training is but little used. Rather, to us, does it seem probable that in a perfect state the man with special scientific and technical knowledge would employ it on those purposes for which it is most useful and that administration would be left to some other person whose qualities best fitted him for the exercise of it. Once more it is the Boulton and Watt type of amalgamation—a great engineer working in double harness with a great business man—that approaches most nearly to the highest efficiency.

We have only to consider the nature of the result that would ensue if all our scientists gave more attention to administration than to technology to see the weakness of the system. In such a case progress would be relatively slow, because the men with the most scientific minds and the highest technical knowledge would be busying themselves with the affairs of account books and time sheets, and would exercise their special faculties in no higher degree than by inspiring those below them. Great and essential as that work is, we cannot but feel that it is better still that they themselves should engage in science and research and the hundred and one technical problems that an engineering factory presents. Mr. Wordingham might indeed find many notable examples of successful firms with which to support his views, but that would be rather because it has been the British practice for years past for the engineer to be an administrator than because a better plan cannot be found. It is rarely indeed that the heads of our great firms are great engineers, great inventors, great scientists. The common course is to delegate such work as requires highly specialised knowledge to subordinates, whilst the chiefs themselves attend to administration, to balance sheets, to sales, and to the never-ending trade union troubles. But it is at least conceivable that were the order reversed, were the chiefs themselves—as a few of them are—men in the full bloom of high knowledge and using that knowledge for the development and progress of industry, whilst all administrative work was controlled by subsidiaries especially trained for that craft, advancement would be more rapid than it now is. Mr. Wordingham may be right in saying that only a trained scientific mind can properly understand the difficulties of the staff, direct their activities and inspire them; but, nevertheless, it does seem a matter for regret that we should spend annually great sums in the technical training of young men if there is no alternative for them but to remain in subordinate positions or allow their technical and scientific acquirements to be no more than a buttress to administrative duties. That—and in so far Mr. Wordingham is on safe ground—is undoubtedly what now happens in the mechanical engineering industries. The young man who looks for financial success may be advised to neglect by degrees his books of science and to turn more attentively to the state of the market, as revealed by his daily paper, and to the study of economics and workshop organisation. As engineers we cannot but regret that it should be so; we cannot but regret that the commission agent and the commercial manager make higher incomes than the engineer, that business is the best science, and science, at best, but a poor business. Fortunately, there are still amongst us a few men, who, whilst engaged in the trade of mechanical engineering, are yet great engineers; but it must with regret be admitted that whilst they receive honour in their profession their wealth is but moderate, as compared with the great business magnates. Yet they have their reward, for who amongst us can doubt that the joy the real engineer derives from successful achievement is at least as great as that of the business man who pockets a big order.

We write, let us admit it, against our own knowledge. We know, alas, that in substance Mr. Wordingham is right; that capable engineers are called upon to give up the mysteries of their craft just because they *are* good administrators, and because they, and they alone, can inspire and direct their staffs. But whilst we know that this condition prevails, we are not convinced that it is the best, we are not convinced that greater progress would not ensue if engineers stuck to their profession and delegated administration to professional administrators. We are, all engineers know it, in grave danger of losing the high science of mechanical engineering. Mass production and subdivided production are making towards its destruction. With hastening steps mechanical engineering is becoming a manufacturer's business in which the man with inventive talents and progressive views is rather a nuisance. Changes and developments are not wanted, for they interfere with the rapidity of production, cause the antiquation of plant, and disturb the comfortable schedules of the administrators and salesmen. It is because we are tending in that direction that Mr. Wordingham is right. Of course, it is good business, but it is not engineering at all, and just because we are confident that there is still scope for real engineering work, we trust that always a large number of our highly trained young men will live according to their destined vocation and leave administration to others.

Water Power Development.

A report like that of the Water Power Resources Committee, summarised below, which is practically unanimous in its general conclusions, except on the one matter of the setting up of a new body of Commissioners, is bound to carry weight and to have considerable effect in furthering legislation on a subject which admittedly needs the attention of Parliament alike in its technical, administrative and legal aspects. Much of the recommendations of the Committee which deal with water power and the administration of matters connected therewith by one or another of the Government Departments concerned, will in all probability meet with a favourable reception from the public. From an engineering point of view it is satisfactory to note that no less than ten of the members of the Committee are engineers, and that these gentlemen, with the reservation mentioned in the report, are practically unanimous with their non-technical colleagues in their recommendations. It is rightly admitted that in this country there is a lamentable lack of engineering and technical knowledge and experience of power water problems in comparison with Switzerland, Sweden, the United States of America and Canada. There is practically no systematised record of river flow existing in the districts where water power is available, and there is no means whereby the acquisition of water rights of individuals can be effectively con-

trolled in such a way as to prevent such rights interfering with the subsequent development of water resources to the utmost advantage of the community as a whole.

The view of the majority of the Committee is that these and other disadvantages will be met, and advantages, which they paint in glowing colours, will be secured by the erection of a body of Commissioners charged with the powers which we have indicated. On the other hand, there is much to be said, especially at the present time, for the view expressed by Mr. Sandford Fawcett and Mr. Tait, both experienced engineers, the former as Deputy Chief Engineering Inspector of the Ministry of Health, and the latter as a practising consultant. That view is that the setting up of a permanent Commssion is not justified in view of the consequential expense and duplication of work. That such a Commission would materially reduce the cost of procedure as compared with that of parliamentary Bill legislation is open to question, and the experience gained during the past year of the proceedings before the Electricity Commissioners does not point to economy in that direction. This is the view held by Mr. Tait. On the whole, it seems to us that public opinion will be strongly opposed to the proposal as involving further expense to the taxpayers. It is evident that a Commission charged with all the powers suggested by the Committee must have an expert staff of considerable magnitude, and it is, we think, illusory to anticipate that the expense, or even a considerable part of it, will be met willingly by a levy on water authorities and by fees. A possible solution involving far less total expenditure may be found in allocating more of the duties of investigation and record, which are proposed for the Commission, to one or more of the already existing Departments already technically staffed, such as the Board of Trade, the Electricity Commissioners, and the Ministry of Health. The legislative functions of the proposed Commission might well be left to Parliament, the methods of procedure being perhaps simplified by an extension of facilities for Provisional Orders and an increase in the powers of the technical departments concerned. The dangers of overlapping and conflict of interests might be met by the constitution of an interdepartmental Committee appointed to deal with applications.

Whether the ends, excellent in themselves, which the Committee unanimously desires to attain cannot be reached by making full use of existing Government agencies rather than by the creation of a new and expensive department is, we are convinced, a matter at least worthy of careful consideration before Parliament is committed to the full extent of the Committee's recommendations.

Literature.

Brassey's Naval and Shipping Annual, 1921–2. Edited by Alex. Richardson and Archibald Hurd. London: W. Clowes and Sons. 25s. net.

The present issue marks the thirty-third year of publication of the "Naval Annual" founded by the first Earl Brassey. Under its new editors the scope of the volume has been extended to include matters of interest to the commercial shipping world, and following the precedent established last year, several chapters are devoted to recent developments in the mercantile marine. At the same time, naval affairs proper continue to receive their due measure of attention. Commander C. N. Robinson, R.N., contributes his usual comprehensive survey of the British Navy during the past year; Mr. John Leyland deals with the progress of foreign navies, with special reference to those of the United States and Japan; and in two brief but informative chapters the editors discuss, with a wealth of statistical detail, the rise and fall of naval expenditure and comparative naval strength at the present period. One article which has already attracted notice is that by Lieut.-Commander Sato, of the Japanese Navy, on the Battle of Jutland. This officer has prepared an acute and impartial analysis of the tactics of Jutland, a battle in which, he thinks, there was neither victor nor vanquished, since both sides failed to achieve the goal in view. In his judgment the action might have been given a more decisive turn had either of the rival commanders-in-chief kept his mind firmly fixed upon the supreme objective, viz., destruction of the enemy. He gives Admiral Jellicoe credit for having baffled the German torpedoes and Admiral Scheer for preserving his fleet from the clutch of a superior foe, but contends that these cannot be true aims in battle, adding, with a slight rhetorical flourish, that "there is only one epilogue in the Book of Battle—destruction of the enemy, and no other." With all deference to Commander Sato, we must enter a caveat against this sweeping statement, for which he will find little support in naval history, ancient or modern. Of the many actions which have been fought at sea, few ended in the complete destruction of one of the opposing fleets, yet decisive results have often flowed from encounters in which the material damage inflicted on the beaten side was comparatively slight. We need only mention the battle of the Yellow Sea, fought on August 10th, 1904, in which Admiral Togo failed not only to destroy the Russian Fleet, but to sink even one of their ships, and in which his own flagship, the Mikasa, was damaged more seriously than any Russian unit. Nevertheless he gained a decisive victory, for the Port Arthur fleet never emerged again. Following Commander Sato's valuable paper are three articles to which the controversy on big *versus* little ships lends a special interest. Admiral Sir Reginald Bacon, who was closely associated with the design of the Dreadnought and captained her on her first commission, takes up the cudgels on behalf of the capital ship. While his closely reasoned arguments should serve as a corrective to the wide claims of the torpedo and aeroplane school, we are not sure that Admiral Bacon has made sufficient allowance for post-war developments in aircraft and their offensive powers. Rear-Admiral S. S. Hall, one of our foremost authorities on submarine warfare, writes on the potentialities of the torpedo, a weapon which, in his opinion, will henceforth play a predominant part in naval operations. His observations on the convoy system, as it would have to be conducted in a future war, should undeceive those who imagine that the problem of defending merchant shipping against submarine attack has been solved. The third of the articles to which we have alluded is by General Sir Sefton Brancker, who treats of "Air Power and Sea Power" from the practical expert's point of view. This is a particularly able study of a highly important subject, and one that deserves to be wisely read. It is General Brancker's conviction that aviation has become, *par excellence*, the weapon of offence. "No war can be won except by offensive action; and consequently the Navy and the Army must give way to the new arm in national importance, and in their claims on national expenditure." Whether this new policy will be adopted remains to be seen. It is certainly not foreshadowed by the relative figures of current expenditure on the three services. Among the contributions of great technical interest are those by Engineer-Vice-Admiral Sir G. G. Goodwin, Engineer-in-Chief of the Fleet, on the auxiliary machinery of ships, and by Mr. F. D. H. Bremner on the electric drive for ships. The Ordnance and Armour Section, always a most useful feature of "Brassey," was somewhat neglected last year, but amends are made in the present edition. Commander Robinson traces the evolution of the modern armour-piercing projectile down to the present day, and shows, incidentally, that the manufacturers were not responsible for the failure of our shells, in use at the Battle of Jutland, to penetrate armour at oblique attack. The illustrations and data which are given of the post-war A.P. projectile afford striking evidence of the progress which has been achieved in the past two or three years. Shells of this type have pierced armour plate at angles up to 30 deg.

The Merchant Shipping Section contains a series of informative articles on shipbuilding, marine engineering, and the economic aspects of the shipping industry. Mr. James Richardson reviews current tendencies in propelling machinery for merchant ships, a subject on which he can speak with high authority; Professor P. A. Hillhouse discusses the cost of speed, and makes some valuable suggestions for exploiting the advantages of high speed without an undue sacrifice of cargo and passenger space; Sir F. W. Black examines the world's resources of petroleum fuel oil, and urges the need for economy in consumption by striving to obtain the maximum efficiency from whatever supplies are made available; and Sir Trevor Dawson writes as a vigorous champion of the commercial airship. The illustrations and tabular matter are well up to the "Brassey" standard, the tables having been recast and amplified. In view of the decisions reached at the Washington Conference, it is probable that an extensive revision of the naval data will have to be made before the next issue is published. In the meantime, however, the "Annual" will retain its position as a reliable and comprehensive index to the present-day standing of the world's fleets of fighting and commercial ships.

London of the Future. By the London Society, under the editorship of Sir Aston Webb. London: Fisher Unwin. 1921. Price 42s. net.

We picture the London Society as a group of very tidy persons—a sort of Betsey Trotwood amongst societies. The carelessness, the happy-go-luckiness of London pains it, and it grieves over lost opportunities. Its ambition in life is to put things right, to make all taut alow and aloft, to remove the pleasant difficulties of traversing our city, to widen roads, improve railways, be-Councilise our parks, and generally transmogrify the dirty and incorrigible rogue into a nice tidy person like itself. We dare say it is right; we dare say London *would* be better for a wash and brush up, but we doubt if it would remain the same London, if it would have the same character, the same individuality, the same charm that it now has. We love cities as we love men as much, if not more, for their faults than for their perfections, and the thought of London without its familiar troubles and difficulties is as distasteful as the thought of the Abbey or St. Paul's without their veneer of London grime, or St. Ethelberta without the little shops nestling round its doors.

We sometimes wonder if it is possible, by taking thought—municipal, co-operative, county-councillor thought we mean—to build a beautiful city. If it is not rather that a city must grow up in its own way, reflecting the periods through which it has passed; here showing great ideas and here paltry ones; now ostentation and anon dignified simplicity, exhibiting now high aspirations and then mental anarchy and iconoclasm hurling down the fond fancies of predecessors and hiding the things they loved, the things through which they expressed what was in them, under plaster and match-boarding. Things may happen to cities whether they will or no, and it is just possible that, despite the London Society or any other municipal Betsey Trotwood, the great heart of the city will have its own way after all, and the reformers will succeed no better than other reformers before them have done, but in the end leave behind them defects for the Bells and Besants of the future to write romances around. New York, after it had grown out of knickerbockers, was tidied up, and squared up, and laid out mathematically as the perfect city. But see what is happening to it. Men could not alter its plan; they could not change the stiff formality of its avenues and streets. They could do nothing with the two dimensions length and breadth, in which the city planner works. But there was a third dimension, height. There they could do what they liked. They could not move sideways or endways, so they moved upwards, and now we have that varied sky-line which is the pride of every good New Yorker.

We learn from the book before us that the London Society has drawn a wonderful map of London, and that it wants to build a huge model of the Metropolis with a gallery around it so that one may look down on it. Surely that is all wrong! Cities are not—not yet—made to be gazed at from the air. They are to be seen from the ground, and it is the effect obtained from that level that counts. London looks a very different place from an aeroplane; then the arrangements of squares and circuses and radiating roads and so on are all laid out neatly for inspection and admiration. Seeing them so and thinking of the care the architect took in laying them out with rule, compass and chain, and then remembering the futility of his work from the level at which we live, where a couple of omnibuses may restrict the vista of the most glorious circus in the world, one is sometimes tempted to think architects might almost as well have left things to chance as far as the plan was concerned. Even in a great cathedral the eye cannot take in the ground plan of the building; how much less can it grasp the superficial ordering of the streets and avenues of a vast city? Does not the charm of old cities lie in their fortuity, their unexpectedness; in the surprise and mystery that every corner contains?

We are pleading, it may justly be said, for mere beauty, and the London Society is thinking of convenience. Yes; that is so. But a beautiful city is worth having, and it is worth sacrificing some convenience to possess it. Efficiency may easily be overdone, and it is regularly overdone in these days. What if for lack of efficiency we get something else, something that is really more worth having, do we not gain by losing? We may get too utilitarian and rob ourselves of the joy of living in our very anxiety to make living easy.

We suppose we have been invited to review this book especially because it contains an essay by Mr. Leaning on London railways. Mr. Leaning's plans are pretty well known. The most striking characteristic of them is the proposal to get rid of several of the great suburban termini and convert them into through stations. It also includes an ingenious network for facilitating communication with outer London and residential areas beyond. We do not believe there is the smallest probability of his scheme or any material part of it being carried out in the present generation or the next, and goodness knows what may have happened to London when the third generation appears. Perchance it will have ceased to grow; perchance new means of communication will have upset all our conceptions; perchance moss will be springing through the cracked concrete of its streets, and the waters of the Thames lapping at the doors of its deserted offices. Gigantic schemes oft defeat themselves by their magnitude. It is so easy to be thorough on paper, and so fascinating! We are not sneering at or slighting Mr. Leaning's proposals. On the contrary, they fill us with admiration. He has done his work thoroughly, and if London lasts long enough; if it continues to grow at its present headlong pace; if people will still go on wishing to live further and further afield and fly, shuttle-like, between their suburban homes and their city offices, shops, theatres and picture houses, then Mr. Leaning's schemes, or something akin to them, may be carried out. Yet, if statistics go for anything, we can never hope to solve the London traffic problem, for all our efforts to meet the load only cause the load to grow bigger. Someone has said that the only cure is to

increase—not decrease—the difficulties of transport. Possibly that would be the best plan; possibly we should be wiser to encourage the growth of a new business centre twenty-five or fifty miles away and so check the growth of a city which is already too big. The time is coming for de-centralisation. New little cities, daughters of London, should be springing up around her and relieving a pressure which, it seems, nothing else can ever remove.

There are many chapters in the book, each one by an authority on his own subject, and a comprehensive introduction by Sir Aston Webb. There are, moreover, many illustrations, and altogether it is a volume that one may while away an hour or two with very pleasantly.

The Geology of the British Empire. By F. R. C. REED. Pp viii. + 480, with maps, 8¾in. by 6in. by 1¾in. London: Edward Arnould. 1921. Price 40s. net.

To condense within 480 pages an account of the geology of the British Empire, even if, as in the present work, Great Britain is left out, is a task of considerable magnitude, but one of great utility. There are, of course, standard works on the geology of the leading countries, but they are not often accessible in country libraries, and information as to Malta, say, or one of the British Atlantic islands could only be obtained by a visit to one of the geological libraries that are not too easily accessible. That compendium of useful knowledge, the "Encyclopædia Britannica," does its best, but it is now somewhat out of date and the details it gives are often on too small a scale. On the other hand, the geological library presents a scattered mass of technicalities that becomes a despair to a hasty inquirer without a guide.

For the last twelve years Dr. Reed has been lecturing to Cambridge students, and has now been persuaded to publish his notes, the condensation of a vast mass of heterogeneous material scattered through Government memoirs and the technical publications of so many geological societies. In eighteen sections he deals with the Mediterranean area, the various parts of Africa now under British dominion, the islands of the Atlantic and the West Indies, Canada and Newfoundland, the Indian Empire and the further Indies, Australia, New Zealand, and Oceania. A short additional section includes the mandatory regions of Mesopotamia and Palestine. The British islands are omitted for obvious reasons, as their geology is so well known, and a summarised account would take space that is better utilised.

A general account is first given for each country of the geological characters and the history and relations of the strata. After that, in smaller type, follow details of the stratigraphy, beginning with the earliest known formations. Then, in larger type again, is presented a brief *résumé* of the economic minerals, and finally a bibliography of references. Some fourteen folding maps and about a dozen sections are given to elucidate the text. In them the several geological divisions are shown hatched in various ways. In view of the expense it would, of course, be too much to expect the inclusion of maps coloured according to the tints generally used, but it is a very great pity that the author has not used a uniform system. The Cretaceous formation, for instance, is represented in five different fashions. Even in the two maps of India and Burma rectangular cross hatching marks Paleozoic in Burma and Cretaceous in India, while the Burmese Cretaceous is diagonally cross hatched. This defect is rather serious when the maps and sections are compared, though it is only a small matter in comparison with the difficulties that arise when the attempt is made to correlate the geology of different countries or even of two parts of the same country. This is well exemplified in the following quotation:—

"Two distinct geological records are thus placed side by side in India, and their mutual correlation, particularly in the case of the unfossiliferous or non-marine formations of Peninsular India, has always been a matter of difficulty. The European standard scale is, moreover, not easily applied to the Indian succession owing to differences in the development and history of the two areas, and the stratigraphical names which can be employed must largely be local, owing to these uncertainties of equivalence. The differences which are invariably connected with the existence of zoo-geographical provinces complicate the problem."

Even the standard trilobite, Olenellus, is not recognisable everywhere, and the many thousand feet of strata below its zone can only be characterised as Pre-Cambrian or Archæan and subdivided locally by local names. Above that zone, even when the fossils are numerous, it is often impossible to say within a few thousand feet of rock or a few thousand years of time whether a deposit was approximately simultaneous in Europe, Africa, Asia, and America. The paleontologist can approximate the development of species under hot and under cold conditions, and in far distant localities separated by seas, oceans, and mountain ranges that cannot be traversed by plants and animals developed locally from common ancestors. With his aid the geographical geologist can trace the development and disappearance of the great land masses and oceans on the surface of the world. And the local geologist has to give local names to the succession of strata in his own country. All this is most admirably summarised by the author for the British Empire in this book, and the local bibliographies are brought well up to date for anyone who does not desire to investigate such recondite problems as the relation between isostasy and the Himalayas.

SHORT NOTICES.

Iron and Steel in Sweden. Edited and published under control of and in co-operation with Jernkontoret by Aktiebolaget Svenska Technologföreningens Förlag, Stockholm, Sweden.—This book is an all-Swedish production. The paper was manufactured in Sweden, it was printed and bound in Sweden, and the covers were made in Sweden of Swedish material. The work was executed with a view to giving all available information to prospective buyers of Swedish iron and steel. Great care has been exercised to publish only authoritative and correct statements. Whilst the articles are primarily written by the different firms concerned, they have been revised under the supervision of Mr. Alf. Grabe, whose special appointment for this purpose was made by the Jernkontoret (Ironmasters' Association). Strict supervision has been extended even to the advertisements which the book contains. Special care and attention has been given to the compilation of the list of products section. The method of arrangement is better than that usually found in productions of the kind. Only names of manufacturers appear in the lists. Agents and firms who trade in the products of the manufacturing firms are confined solely to the advertising sections. A map showing the situation of Swedish iron and steel works is included, and illustrated descriptive articles are given of the different works described. The historical data is supplemented with information about the manufactured products which the firms export. We are asked to say that anyone who is interested in this little volume may obtain a copy on application to Mr. H. Eriksson at the Swedish Consulate in London, 329, High Holborn, W.C. 1.

A Catalogue of British Scientific and Technical Books. Covering every branch of science and technology, carefully classified and indexed. London: British Science Guild. 1921. Price 10s. net.—It is the hardest thing in the world to make a selection of books that will satisfy everyone, and perhaps the Committee entrusted by the British Science Guild with the preparation of this catalogue did right in including all the names it could get hold of, but the result is that a good many useless volumes are covered. Yet as it has been found possible to catalogue the whole scientific literature of Britain, other than pure educational works, in some six thousand titles, the volume is not large. We say the whole, but it must be understood that as far as we can see only what may be described as current works are included; that is to say, works still found in the publishers' lists. A compilation of the kind no doubt has its uses, but it has also its disadvantages—it causes the inclusion of many works not worth retaining and the omission of many books which, though only now to be obtained at second-hand dealers, are the best of their kind. An interesting feature of the volume is the table of classification, which should prove useful to anyone with a fairly large scientific and technical library that needs to be set in order. The adoption of a standard classification for medium-sized libraries would be a great convenience, and here we have one to hand.

BOOKS RECEIVED.

British Railways and the Great War. By E. A. Pratt. Two volumes. London: Selwyn and Blount, Limited. 21, York-buildings, Adelphi, W.C. 2. Price 42s. net.

The Motor Electrical Manual. All about motor car electrical equipment in simple language. Fully illustrated. London: Temple Press, Limited, 7–15, Rosebery-avenue, E.C. 1. Price 3s. net.

Report of the Water Power Resources Committee.

THE final report of the Committee appointed by the President of the Board of Trade in 1918 to inquire into the water power resources of the United Kingdom was issued on Wednesday. Although the Committee when first appointed under the chairmanship of Sir John Snell was directed to examine and report upon water power resources only, it became apparent at an early stage in its investigations that the restriction to power supplies which had been imposed upon it would hamper its work, and that in its consideration of the matter water resources available for power purposes could not be divorced from questions bearing on the water requirements of public supplies and trade purposes. The terms of reference to the Committee were accordingly extended in October, 1919, to cover the water resources of the country generally, and the *personnel* of the Committee was enlarged. The Committee has issued four interim reports, the first of which was preliminary in its nature and is superseded entirely by the final report. The second interim report dealt with the Committee's conclusions concerning the nature of the control of water resources which were considered desirable, and these conclusions are confirmed and summarised in the final report. The third report, issued in December, 1920, related solely to tidal power, and expresses the final views of the Committee; and the fourth was the report of the Sub-committee which considered the water-power resources of Ireland.

The final report now before us is a lengthy document—with its appendices it covers 178 pages—and is signed by nineteen out of the twenty members of the Committee, although one of them, Mr. Sandford Fawcett, of the Ministry of Health, appends important reservations. Mr. W. A. Tait, the one member who does not sign the main document, submits a dissentient report.

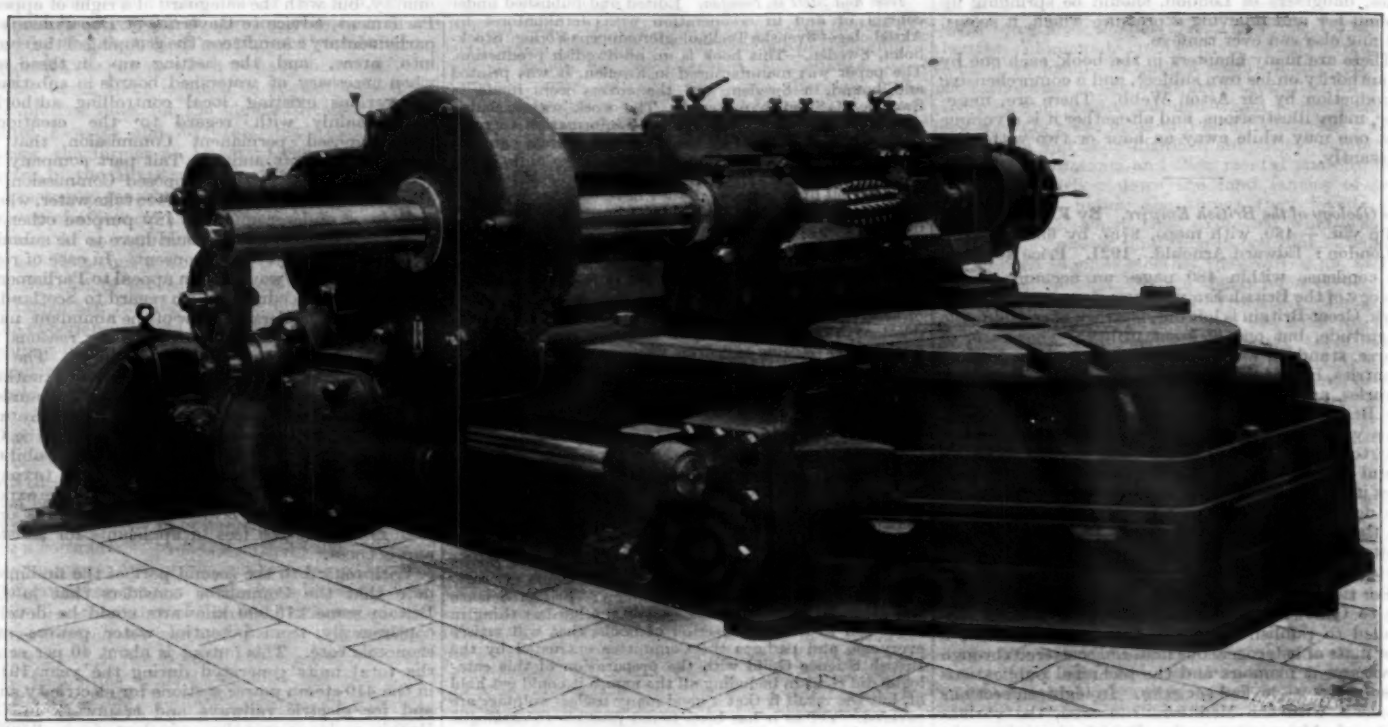
The recommendations of the majority of the Committee fall under two main heads—first, the general control of water supplies, and, secondly, the control of water for power purposes. As to the first, the Committee recommends the establishment of a Water Commission for England and Wales, whose duties should include the compilation of data, the allocation of water rights in the interests of the community, but with the safeguard of a right of appeal to Parliament, advice to Government Departments and parliamentary committees, the grouping of the country into areas, and the setting up in these areas when necessary of watershed boards in substitution for various existing local controlling authorities. It is mainly with regard to the creation of this proposed permanent Commission that Mr. Sandford Fawcett and Mr. Tait part company with their colleagues. If the proposed Commission were constituted, all future proposals to take water, whether surface or underground, for any purpose other than private or domestic use, would have to be submitted to the Commission for its consent. In case of refusal of consent, there would be an appeal to Parliament by private Bill procedure. With regard to Scotland, the Committee considers, in view of the abundant nature of the supplies available and for other reasons, that no controlling Commission is required. The Irish Sub-committee recommends a controlling authority on somewhat similar lines to the proposed Commission for England and Wales. As to the means by which the cost of the Commission should be met, the Committee is evidently impressed by the advisability of avoiding any additional burden on the taxpayers, at least in theory, for it proposes that the expenses should be met by a levy on existing water undertakings and by the fees of applicants for assistance and licences.

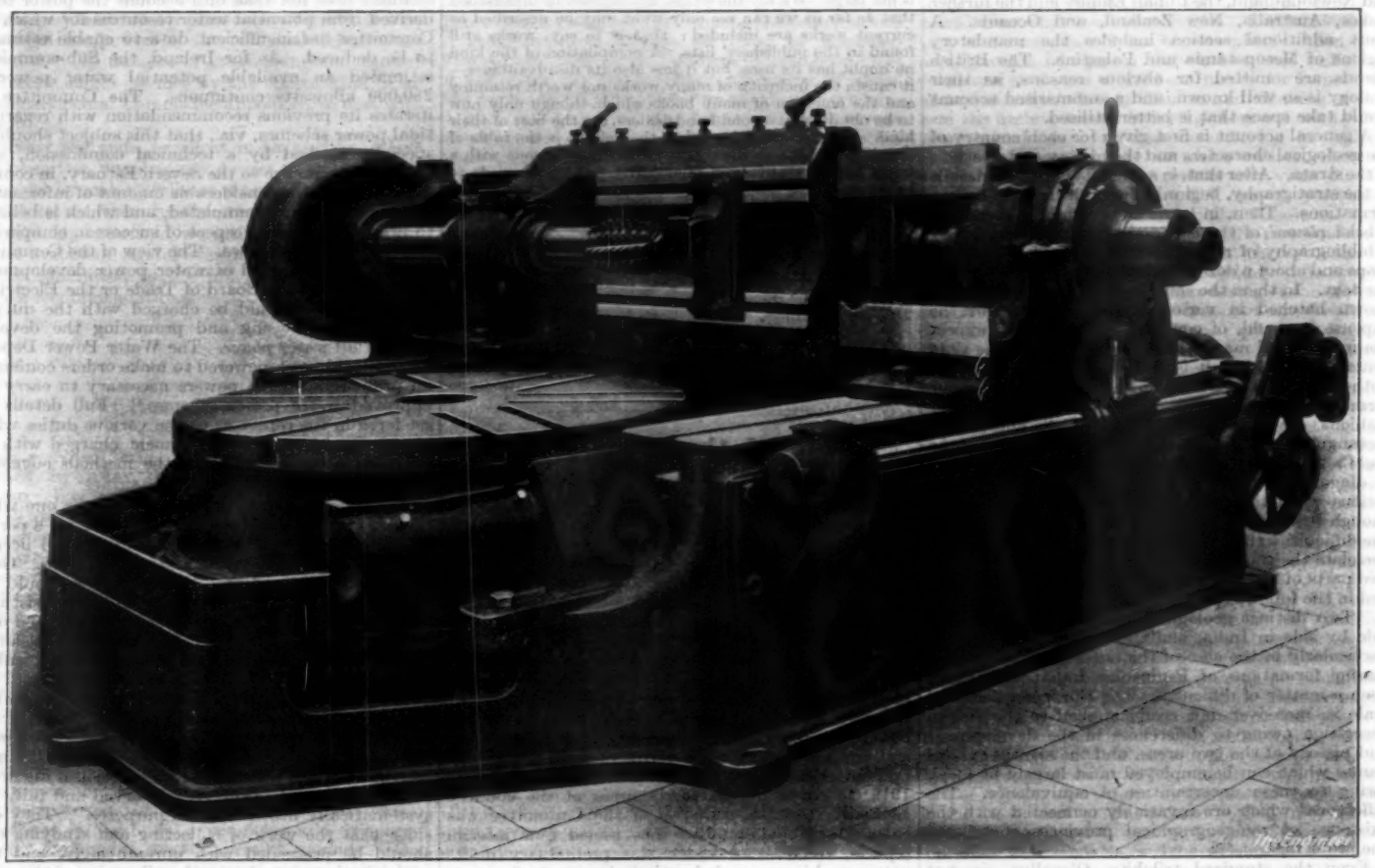
With regard to the second part of the findings, we note that the Committee considers that in Great Britain some 210,000 kilowatts could be developed continuously from potential water powers at an economic rate. This output is about 40 per cent of the total units generated during the year 1917–18 in the 410 steam power stations for electricity supply and for electric railways and tramways in Great Britain, and represent the equivalent of some 3,000,000 tons of coal consumed in power production. This estimate does not take into account the power to be derived from potential water resources for which the Committee has insufficient data to enable estimates to be deduced. As for Ireland, the Sub-committee estimated an available potential water power of 280,000 kilowatts continuous. The Committee reiterates its previous recommendation with regard to tidal power schemes, viz., that this subject should be specially studied by a technical commission, with particular reference to the Severn Estuary, in connection with which a considerable amount of information has already been accumulated, and which is believed to present the best prospect of success in comparison with other tidal schemes. The view of the Committee on the future control of water power developments is that either "the Board of Trade or the Electricity Commissioners should be charged with the duty of studying, supervising and promoting the development of all water *power*. The Water Power Department should be empowered to make orders conferring on promoters all the powers necessary to carry out approved water power schemes." Full details are set forth in the report as to the various duties which would devolve on the Department charged with the proposed powers, and as to the methods suggested for procedure and regulation.

An interesting proposal among these is one which provides for the reversion to the State after a period, which would normally be 100 years, of all licences or rights granted in respect of water power. Other recommendations of importance, which would not appear to be entirely dependent on the constitution of the proposed Commission, but could be acted upon by existing Departments empowered by legislation, deal with such questions as river pollution, fishing rights, compensation water and land drainage. The Committee admits that the entire programme which it has outlined would be a work of considerable magnitude, the completion of which would necessarily take some time, but the signatories "are thoroughly convinced of the necessity of such action if our water resources are to be properly conserved and fully and systematically utilised for all purposes." They consider that the work of collecting and studying data should be proceeded with unremittingly, and that authoritative control over the allocation of the water resources of England and Wales by some informed technical body has become a matter of vital moment. Further, they are of opinion that it is essential that the process by which compulsory powers can be acquired to use and abstract water should be cheapened and simplified. Finally, they sum up their proposals as to the means by which they consider the desired results will be obtained, in the following words: "We consider, therefore, that the Water Commission and the statutory Inter-departmental Water Committee should be constituted without delay, that powers should at once be given to the Board of Trade or the Electricity Commissioners to enable them to study, supervise and control the development of water power, and that all the Departments concerned in water should be empowered to confer on the promoters of approved schemes involving the use of water all the necessary powers by means of Orders."

LARGE WORM-WHEEL GENERATING MACHINE

WILLIAM MUIR AND CO., LIMITED, MANCHESTER, ENGINEERS





New Worm Gear Generating Machine.

THE accompanying illustrations represent a large new worm gear generating machine by Wm. Muir and Co., Limited, Manchester. The machine, as will be gathered from the engravings, is exceptionally heavy and powerful, as was necessary, since it was designed to deal by means of a hob 12in. diameter with cast steel gears 5ft. diameter and 3in. pitch. The bed is of the double girder type, very deep to give the necessary rigidity, and carries at the front a large cradle and table, to the latter of which is, of course, attached the master dividing worm wheel. This wheel is made by the same process that Messrs. Muir have adopted in producing the large master worm wheels of turbine gear hobbing machines, and the makers claim that it is consequently exceptionally accurate. The worm and wheel run enclosed in the cradle and in oil, and provision is made to take up both wear and backlash. Round the cradle and table is a guard which conducts the lubricant from the cutter back through a sump in the bed to the tank, the sump retaining the cuttings, which fall into a tray let into the side of the bed. During cutting, this tray can be periodically removed and emptied. The spindle is driven from a very fast running side shaft, which operates through a differential gear on to a fast pitch worm and wheel, the whole of this gearing being totally enclosed and running in oil. Provision, however, is made to enable the machine to be used with or without the differential gearing. To this end, means are provided which, when the worm controlling the differential gear is thrown out, lock the latter *en bloc*, thus preventing the differential wheels revolving on their own centres. The differential gear is controlled by change wheels driven from the feed screw in the cross slide. The change gears which control the number of teeth being cut are mounted on the back of the machine and drive down through gearing which can be varied in the ratio of 6 to 1, so as to avoid exceptionally fast speeds of the change gear when cutting worm wheels with a fast lead. A special dividing motion is also fitted. It is independent of the change wheels when using a fly cutter in producing gears in which the number of leads of the worm is a factor of the number of teeth in the wheel. The feed motion is operated from the shaft driving the table through a reversing box and change wheels, and drives up to the cross slide through a worm and wheel. This motion is arranged either to feed the hob slide along the cross slide or to feed the cross slide bodily towards the work, to enable worm wheels to be cut by parallel hobs by "sinking in." The hand wheel seen at the end of the cross slide controls both motions, and is indexed in thousandths by means of a micrometer. The machine is driven through helical gearing by a 10 horse-power reversible motor.

Pulverised Coal as Fuel in the United States.

No. I.

THE use of pulverised coal as fuel for kilns, furnaces and stationary boilers in the United States has reached an important position, with a total consumption of nearly 10,000,000 gross tons in 1919. Of this amount about 6,000,000 tons were used in the kilns of cement manufactories, 2,000,000 tons in furnaces at steel and iron works, 1,500,000 tons in the smelting furnaces of copper works, and 200,000 tons in boilers for the generation of power. This method of utilising coal as fuel for boilers has passed the experimental stage, and its practicability is established, but there is need for much more trustworthy information as to the comparative cost of power production with pulverised coal and with coal burned in other forms.

Recognising this condition, a committee of the American Fuel Association in 1920 made an endeavour to obtain sound comparative figures of cost, but it had to report its inability to procure such figures. Reports from several users were to the effect that they were getting successful results with pulverised coal, and that plants were operating more economically with this fuel than they had been with ordinary methods of coal burning or with oil fuel. At none of these plants, however, had comparative tests been made, and therefore no exact figures could be given. The committee pointed out that accurate figures of cost were necessary to establish the standing of the pulverised coal system as an improved and more economical method of producing power.

Records of one test of this kind have been given by Mr. John Anderson, chief engineer of power plants for the Electric Railway and Light Company of Milwaukee, U.S.A., which company supplies current for tramway, railway, lighting and power purposes. At its Oneida-street station about two years ago the company equipped five of the ten 468 horse-power water-tube boilers for burning pulverised coal, the other boilers having Riley mechanical stokers. After much development work and numerous changes in design and details a running test was made to determine the relative operating costs and net efficiencies of pulverised coal and a modern system of firing with mechanical stokers. This test covered a period of 99 hours, or 495 boiler-hours, the boilers being maintained at 120 per cent. of full load. The results as regards electrical energy generated and fuel consumption are summarised in the accompanying table.

Comparative Results with Pulverised Coal and Stoker-fired Coal.

	Pulverised coal system.	Mechanical stoker system.
Energy consumed by conveyors, crusher, dryers, fans, &c., in kilowatt-hours	5.73	—
Energy consumed by pulveriser, kilowatt-hours	16.72	—
Energy consumed by stokers and blowers, kilowatt-hours	—	10.94
Total energy, kilowatt-hours	22.45	10.94
Coal equivalent at 1.5 lb. per kilowatt hour, pounds	33.68	16.41
Coal consumed in drier furnace, pounds	25.66	—
Total coal and equivalent, pounds	59.34	16.41
Cost.		
	Dols. cents.	Dols. cents.
Labour—preparing coal	0 14.3	0 0
Labour—firing	0 11.2	0 14.0
Labour—removing ashes, in plant	0 2.5	0 6.4
Drier fuel	0 5.1	0 0
Electric energy: coal per kilowatt-hour at 1.5 lb.	0 6.8	0 3.3
Maintenance: Labour and material	0 6.3	0 9.7
Total cost of fuel preparation, firing, ash disposal and maintenance	0 46.2	0 33.4
Price of coal as purchased, per ton	4 0	4 0
Total cost per ton	4 46.2	4 33.4
Cost per ton of coal in pulverised coal system over stoker system	0 12.8	—
Efficiency.		
Actual gross efficiency, per cent.	80.67	76.80
Net efficiency after all incidental costs, per cent.	72.32	70.88
Difference in favour of pulverised coal, per cent.	1.44	—

This test was of especial importance in view of the fact that both systems were operated in one plant and under similar conditions. The results are more directly comparable, therefore, than those of two separate plants operating the two different systems. Some observations upon this test have been made by Mr. Paul W. Thompson, engineer of power plants for the Detroit Edison Company, who was present at the time and was favourably impressed with the pulverised fuel installation from an operating point of view. The boilers were subjected to regular normal operation, except that the rating was held at practically a constant figure, while no attempt was made to obtain an efficiency which would not be obtained under normal operation of the plant. The boiler-room operation in the case of the pulverised coal was much simpler than with a stoker. In fact, when once the speed of the pulverised coal feeder was set to give a certain rate of steaming of the boiler there seemed to be no reason why this rating could not be maintained continuously—as far as the furnace was concerned—without its being necessary to make any changes.

According to Mr. Thompson, many losses and observations necessary with stoker operation are eliminated when pulverised coal is used. Efficient combustion is maintained without continual supervision by an experienced operator, and from the standpoint of reliability of operation he thinks the advantages are with the pulverised fuel. This item is of serious consideration in plants designed with a capacity of 4.5 kilowatts or more per installed boiler horse-power, where the losing of a boiler because of its stoker at the time of maximum load on the station may seriously overload the remaining boilers or make it necessary to drop a portion of the load on the plant.

The ash was a fine impalpable powder, and was removed twice during each twenty-four hours. Although a large portion of the ash resulting from combustion was carried through the boiler and out of the chimney, it was so fine that even a moderate wind could carry it to a considerable distance before it settled. Even when the ash deposit was blown out of the tubes, which was done three times a day, Mr. Thompson found no noticeable precipitation of ash in the streets. Slagging occurred at times as a result of failure to admit sufficient air, the direct cause being that the men in charge were over-anxious to obtain a high percentage of CO_2 in the flue gas. Although the removal of the slag presented some difficulty, it was possible to maintain the rating on the boiler during this operation by increasing the coal feed, which resulted, however, in a slightly decreased efficiency. In Mr. Thompson's opinion a little more experience will make it an easy matter to check slagging as soon as it begins.

The banking of boilers is avoided with pulverised fuel, for when it is required to cut out a boiler, it is only necessary to shut off the coal feed and close all the dampers and auxiliary air inlets to the furnace. At the plant tested it was found possible to maintain the boiler pressure for about ten hours by the radiant heat stored up in the furnace and boiler setting. The loss which occurred, and which might be compared to the banking loss in a stoker-fired boiler, was the heat radiated from the boiler and setting. This loss was equivalent in amount to that required to re-heat the boiler and setting to the temperature attained when steaming. In a plant where the ratio of boiler hours to boiler steaming hours averages 43 per cent. or more, which corresponds to an average daily plant load factor of 67 per cent., the saving in this way by the use of pulverised coal is worth considering. Assuming 0.2 lb. of coal consumed per boiler horse-power banking hour in a plant equipped with underfeed stokers, this loss amounts to about 1.5 per cent. In a pulverised fuel plant, however, the loss should be reduced easily to 0.8 per cent., with a resultant net saving of 0.7 per cent. on this item of banking.

As to general results and prospects of the pulverised coal system, Mr. Thompson remarks as follows:—

"It is not believed that under test conditions over a period of constant boiler rating the efficiency obtained with the use of pulverised fuel will exceed that which has been obtained from the best stoker practice under similar operating conditions. Under normal operation, however, it is believed that the elimination of the many variable conditions entering into stoker operation will result in higher efficiency for the pulverised fuel installation. Overall efficiencies of boiler, furnace, and grate as high as 82 or 83 per cent. have been obtained on test with stoker-fired boilers, but normal operation day in and day out seldom exceeds 76 per cent. in the very best practice, where highly skilled help is employed in supervising the boiler-room operation. The gross overall efficiency of boiler and furnace of 70.6 per cent. as obtained from the results of this test would unquestionably have been higher had the boiler been cleaned prior to the test. As a matter of fact, each boiler had been in operation prior to the test approximately 600 hours since being entirely cleaned.

"Certainly the results obtained in the pulverised fuel burning plant as a whole, where the equipment was installed and made to fit into an old plant originally equipped with mechanical stokers, are encouraging enough to warrant serious consideration of the use of this fuel in future stations. There are many improvements which can be made in the design of a new plant, especially in the design of furnace, situation of drying and coal pulverising equipment, method of coal handling, drying and pulverising, method of ash handling, slag prevention, possibility of using waste gases for the drying of fuel—all of which will have an effect on the efficiency which may ultimately be obtained. The application of pulverised fuel to central generating stations has been in use to a very limited extent for several years, but there still remains much experimental work to be done before we can hope to exhaust all the possibilities for increased efficiency, and bring it to as high a state of development as is the mechanical stoker system at the present time."

At this Milwaukee plant the coal is delivered by barges or by a collier with belt conveyors for putting its cargo ashore. After being carried by a conveyor over a magnetic separator pulley for the removal of any iron particles or "tramp" iron, it is delivered to the raw coal storage bin. Its preparation as fuel begins with a disintegrator from which it passes to a double-shell dryer, the gases exhausted from which are passed through a cyclone separator for the removal of dust. The dried coal goes to another set of bins, from which it passes to the five-roll pulverising mills. Screw conveyors carry the final product to the fuel bins, from which similar conveyors or feeders supply it to the air mixing chamber, whence it is blown into the furnace.

The largest central power station to use pulverised coal for generating steam is now under construction for the same company which owns the plant at which the above-named tests were made. This new plant is on the shores of Lake Michigan, about a mile south of Milwaukee, and will have a total capacity of 200,000 kilowatts. It will be built in units, however, of 80,000 and 40,000 kilowatts. In this situation it will have an abundant supply of excellent water for boiler feed and condensing purposes, and piers will be built later for colliers which will deliver the coal to a conveying and storage system. The main power equipment as at present planned will consist of two turbo-generators of 20,000 kilowatts, each having a three-pass surface condenser. Steam at 265 lb. pressure and 200 deg. Fah. superheat will be supplied by eight water-tube boilers, each rated at 1300 horse-power, but to be operated at 250 per cent. of rating. At the rear of each boiler will be an economiser, with an exhaust fan to assist the natural draught. Dust from the economisers will fall into hoppers and be carried away by the vacuum ash-handling system. Two chimneys serve four boilers each. This new plant was designed by Mr. John Anderson, chief engineer, on the basis of his experience with the Oneida-street plant already referred to.

Coal is delivered in railway wagons of 30 to 40 tons capacity. The wagons are passed through a dumping machine at the rate of about twenty cars per hour, the machine tilting the car in a cradle so as to discharge its contents into a storage bin. A reserve supply will be maintained also in a stockyard having parallel lines of rails between which the coal will be piled by locomotive cranes handling grab buckets of 2 yards capacity.

In the coal handling and preparing system as described in the American journal *Power*, the coal from the main storage hopper will be carried first by a 48in. belt conveyor to a rotary screen, the head pulley of the conveyor being highly magnetised so as to carry iron particles to its under side and thus separate them from the coal. Coal of 2in. size and over will be retained by the screen and delivered to a two-roll crusher. The crushed coal with the fine coal that passes the screen will go to a hammer mill, which will reduce it to ¼in. size and deliver it to a 36in. belt conveyor, which will carry it to the pulverising plant. The conveyor will be 385ft. long, and will rise 91ft. in that distance. The designed capacity of the crusher plant is 150 tons per hour, or 250 tons if fine coal is delivered that can be sent at once to the hammer mill. Space is provided for a duplicate equipment of rotary screens, crushers and hammer mills, and when this extra equipment is installed the speed of the conveyor from the storage hopper will be doubled.

At the pulverising plant the conveyor from the crusher house will discharge the coal on to a transverse belt, which will distribute it to three parallel conveyors passing over the raw coal bins. Automatic trippers on the conveyors will maintain an even supply in the seven bins, which are designed to have a combined capacity of 3500 tons. Three 12in. screw conveyors under the bins will feed the coal through automatic weighing machines to three indirect-fired rotary driers 42ft. long and 5ft. 6in. diameter, heated by gas from furnaces burning pulverised coal. Here the moisture content of the coal will be reduced to about 1 per cent. The gas exhausted from the driers will be blown through cyclone separators about 14ft. in diameter, to recover any coal dust contained in the gas. Finally, the dried coal will be carried to the eight 25-ton feed bins of the pulverisers by duplicate and parallel installations of continuous bucket elevators and 16in. screw conveyors. Each set will have a capacity of 60 tons per hour, which is the combined capacity of the three driers, so that either system of conveyors will be able to handle the entire output in case of accident to the other system.

The eight pulverising mills will be of the ball type, with a total output capacity of 48 tons per hour. They are to be operated on the air separation system, with which no screens are required. An exhaust fan driven by the shaft of the pulveriser will draw in a current of air through the mill, the velocity of the current being such that it will carry off only those particles which have been ground to the necessary degree of fineness. The current of fine dust and air will be passed through a separator, where the coal dust will be collected, the air being led back to the mill, thus making a continuous circuit. From the collecting hoppers of the separators the pulverised coal will be conveyed to a 50-ton storage bin which will supply a pneumatic conveying system for transporting the coal to four sets of bins over the firing floor of the boiler-room, each set having a capacity of 150 tons.

Two different types of burners will be installed in order to compare them under actual operation, so as to adopt the one that is the more satisfactory when the plant is enlarged. Six of the boiler furnaces will be fired each with three of the Combustion Engineering Company's duplex burners placed vertically through the top of an extension furnace or "dutch oven." About 15 per cent. of the required volume of air will be blown in with the fuel, the remainder being admitted through a number of holes provided in the front wall of the furnace and fitted with doors hinged at the top for regulating the supply. The other two boiler furnaces will each have four "Fuller" burners of the horizontal type placed in the front wall of the furnace. Part of the air supply will be admitted with the fuel and the remainder introduced through an annular space around the nozzle of the burner. With either of these systems the flame temperature will be kept below that at which slagging of the ash content of the coal will begin, so that this ash will be simply a fine dust, partly deposited on the hearth and partly carried away with the flue gases. The dust collecting in the furnace will be removed through clean-out doors in the basement of the boiler-room, and fed to the pipe line of a vacuum conveying system for delivery to an ash storage bin.

Sorbitic Steel for Tires.

The accompanying tables show the results of tests made with six tires—three railway tires, 2ft. 9½in. internal diameter and of 5½in. by 3½in. section, and three tramway tires of 2ft. 3½in. internal diameter and of 2½in. by 2½in. section. Each set of three tires was made from the same cast of steel, and one of each set was treated by the Sandberg Sorbitic steel process, one was normalised by being re-heated to 850 deg. Cent. for the railway tire and to 840 deg. for the tramway tire, and one was untreated. The tires were made by Steel, Peech and Tozer, Limited, at whose works they were also treated and the tests made.

Before drawing attention to these results, it may be useful to remember that, as reflected in the new class of tire—Class E—of the British Standard Specifications for locomotive, carriage and wagon tires, the tendency of recent years has been in the direction of raising the tensile strength and chemical hardness. The Class E tires, just mentioned, call for an ultimate breaking stress of from 63 to 69 tons per square inch with a minimum elongation of from 10 to 8 per cent. Even a higher tensile strength has been asked for by some railway engineers. All these efforts aim at increasing the life of tires, or, to speak more correctly, the period between re-turning. Were this period extended there would be a corresponding reduction in the loss of earning capacity of the vehicle—locomotive, carriage or wagon—due to its having to be withdrawn from traffic for attention to the tires. Furthermore, repair shops would be less occupied, and less accommodation would be required for vehicles awaiting repairs, other vehicles would receive attention earlier and be out of traffic for a shorter time, and, finally, the longer intervals between re-turnings would mean less material and less labour expended for repairs per vehicle per annum.

This much-desired greater wear can be obtained by an increase in the tensile strength of the steel, but it may also be secured by improving the structure of the steel. Given two steels of equal ultimate breaking strength, that with the finer granular structure will offer the greater resistance to sliding and rolling abrasion wear and to wear due to detrusion. Medium carbon steel, subjected to the usual normalising process, when etched and examined under the microscope, is seen to have a granular structure consisting of a network of ferrite surrounding masses of pearlite. By suitable heat treatment of the same steel, however, it is possible to break down the ferrite network and, at the same time, to refine the pearlite grains so that they no longer show the laminated structure characteristic of a normalised steel. Such treatment is said to produce a sorbitic structure which, owing to its greater homogeneity, offers considerably greater resistance to abrasion than the pearlitic structure. Any particular steel in the sorbitic condition shows also greater tensile strength and greater hardness than the same steel does in the pearlitic condition. As a result of a great deal of experiment a process for producing a suitable structure of steel has been invented and perfected by Messrs. C. P. Sandberg, 40, Grosvenor-gardens, London, S.W. 1. The process consists of cooling the tire at a certain rate through the critical range of temperature by subjecting it, as it slowly revolves, to the blast of a large quantity of moist air.

That this process is successful in obtaining an improved ultimate tensile strength and hardness of tires is manifest from the results given in the tables. The micrographs we reproduce on the next page show very clearly the difference in structure between the treated and untreated tires. Those at 250 diameter show how the coarse pearlite structure has been broken down, whilst those at 1000 diameter show that the lamellæ of pearlite have been refined by the process and the structureless sorbite fixed. The treatment is not a mere surface hardening; it can be regulated so as to produce the sorbite structure to any desired depth.

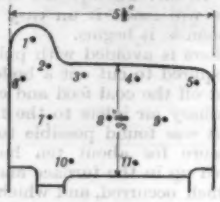
Although the results of the tests speak for themselves, attention may be drawn to the fact that whilst the steel gave a tensile strength of 57.32 tons per square inch when untreated and direct from the mill, and 58.21 tons when normalised, the ultimate breaking strength, after being treated, was 76.4 tons per square inch, with a yield point of 58 tons per square inch—the last figure being practically the same as the ultimate breaking stress of the untreated tire. Owing to the higher carbon content of the steel in the tramway tire, the effect of the treatment there is more marked; an ultimate breaking stress of 81.2 tons per square inch was obtained. The elongation in both cases is very satisfactory, while the severe punishment the tires withstood under the drop tests shows that an ample margin of safety exists. The latter tests indicate also that the deflection is relatively lower and more gradual as the tests proceed.

Steels of a lower carbon content, such as those which, in their normalised condition, met the requirements of the British Standard Specification, Class C, have been very satisfactorily treated by the Sandberg process, and the results obtained in service have been most encouraging. We are told that in one such case electric motor tires which, in their untreated condition, had an ultimate breaking stress of 52 tons per square inch, and in the treated condition a tensile strength of 66 tons per square inch, showed, in actual service conditions, an average increased life of 72 per cent. In another case, with tires of a similar character, the mileage between re-turnings was increased by 70 per cent.

TABLE I.—*Railway Tires, 2ft. 9½in. internal diameter, 5½in. by 3½in. section.*

Analysis:—Carbon, .73; silicon, .313; manganese, .74; sulphur, .033; phosphorus, .038.
All tires made by the United Steel Company.

Tire No.	Treatment.	Drop tests. 10ft.	15ft.	20ft.	25ft.	30ft.	30ft.	30ft.	30ft.		Tensile test. Breaking stress, tons per sq. inch.	Yield point, tons per sq. inch.	Elongation, per cent.	Reduction, per cent.
		Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.					
1	Full Sandberg	½	1	1 7/16	1 13/16	2¼	2½	3 1/16	3½	Not broken	76.4	58.0	14.0	15.8
2	Cooled in Atmosphere, reheated to 850 deg.	½	1	1 3/16	2½	3 5/16	4 13/16	5 1/16		Broke at bottom	58.21	—	13.0	18.3
3	Cooled in atmosphere	½	¾	1½	2 1/16	Broke at bottom					57.32	—	10.8	10.08

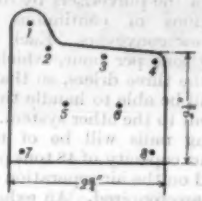


Tire No.	1	2	3	4	5	6	7	8	9	10	11
	Brinell numbers. 3000 kilos. on 10 mm. ball for 15 sec.										
1	331	311	321	321	331	302	302	302	302	255	269
2	248	248	241	241	241	248	241	241	241	235	230
3	269	262	262	262	269	262	262	255	255	255	248

TABLE II.—*Tramway Tires, 2ft. 3½in. internal diameter, 2½in. by 2½in. section.*

Analysis:—Carbon, .78; silicon, .322; manganese, .71; sulphur, .033; phosphorus, .036.
All tires made by the United Steel Company.

Tire No.	Treatment.	Drop tests. 3ft.	5ft.	7ft.	9ft.	11ft.	13ft.	15ft.	Tensile test. Breaking stress, tons per sq. inch.	Yield point, tons per sq. inch.	Elongation, per cent.	Reduction, per cent.
		Inch.	Inch.	Inch.	Inch.	Inch.	Inch.					
7	Full Sandberg	1 1/16	1	1⅛	1 1/16	2⅛	3⅛	Broke	81.2	52.0	13.0	20.2
8	Cooled in atmosphere, reheated to 840 deg.	7/16	1 1/16	Broke					58.92	—	15.0	23.04
9	Cooled in atmosphere	½	1¼	Broke					61.96	—	Broke off close	



Tire No.	1	2	3	4	5	6	7	8
	Brinell numbers. 3000 kilos. on 10 mm. ball for 15 sec.							
7	341	341	341	341	321	331	269	285
8	255	255	255	262	241	255	248	255
9	285	269	269	285	269	269	262	285

Junior Institution of Engineers.*

Is it right that a man who has attained a high degree of scientific or technical knowledge should devote his talents and acquirements to purely administrative work? To fix the ideas, consider the head of a large research laboratory having many departments and dealing with highly recondite subjects. In such an establishment there is, of necessity, a very large amount of work which is in no sense scientific; in all probability, work of this character will occupy the greater part of the time of the man in charge. It may well be argued that, in attending to the details of organisation and the co-ordination of the work of the various departments, the scientific man is wasting his time and, at first sight, such a contention would seem to carry a good deal of weight. On consideration, however, one must come to the conclusion that the contrary is true. Only a trained scientific mind can properly understand the difficulties of the staff or efficiently direct their activities. In my judgment it is essential that scientific and technical work should be directed by scientific and technical men, and, if this be granted, there is no alternative to the man at the head foregoing to a very large extent the purely scientific or engineering work which he is capable of carrying out in order that the whole of his team may work together and may be inspired by their leader to fresh conquests of nature. Only through guidance by one of their own kind can such inspiration come. This illustration will serve to indicate that, in advocating the employment of engineers in administrative positions, we are necessarily making some sacrifice of individual activity in purely engineering directions.

Water Power.—It is customary to regard British water powers as practically negligible, but the careful survey and inquiry carried out by the Water Powers Resources Committee of the Board of Trade have shown that, in Scotland alone, there are seventeen water powers, aggregating 183,500 continuous electrical horse-power, available without reckoning a very large number of small powers. In Wales and to a lesser degree in England and in Ireland also there are considerable water powers.

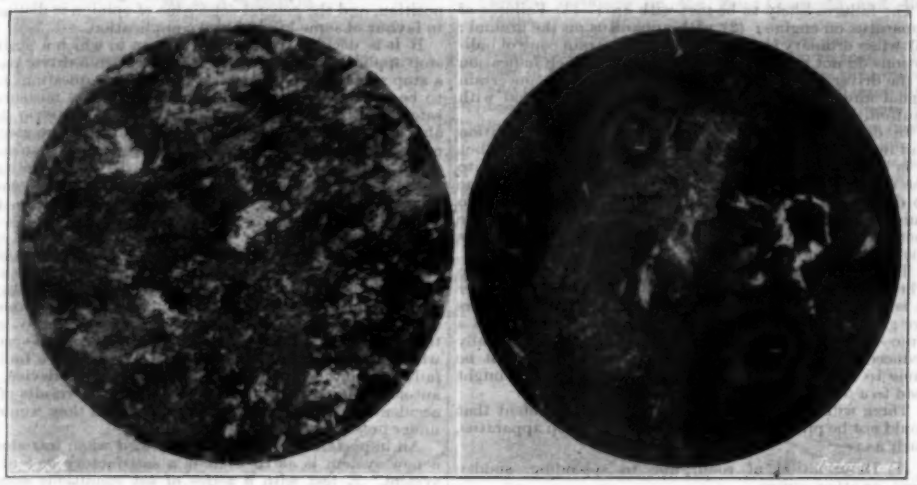
In the final report of the Water Power Committee of the Conjoint Board of Scientific Societies the amount of water power available in the whole of the British Empire is given as 60 million horse-power, of which only 5 per cent. has so far been developed. This compares with 32 million horse-power in the United States, of which 20.3 per cent. has been developed, and with 47,300,000, which is given as the aggregate for Germany, Italy, Switzerland, Spain, Sweden, Austria, Hungary, France and Norway, and of this 18 per cent. has been developed.

These figures show that as an Empire we are in a better position than any other individual State in the world and therefore, if the worst comes to the worst and our coal fails us, our Empire can still hold its own in the industrial world so far as power production is concerned, though clearly there would have to be a good deal of emigration from the British Isles!

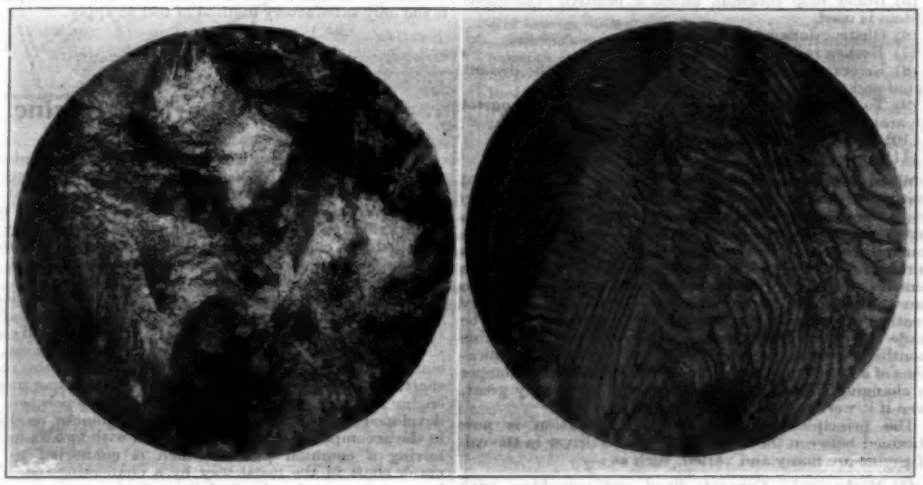
The possession of water power, however, by no means implies that the nation using it is in a better position than one employing power produced from fuel of reasonable price and quality. The Water Power Resources Committee reporting in 1919 give, as a result of their surveys and estimates of the nine Scotch schemes into which the seventeen powers investigated were grouped, a figure of £51.3 per kilowatt developed as the capital cost, and they state that "it would be possible for a water-power scheme of, say, 5000 electrical horse-power or upwards to compete on an equality with the very best steam power station, assuming 12,500 British thermal units coal at 10s. per ton delivered, provided that the cost of developing the water power did not exceed about £60 per effective electrical horse-power." For smaller schemes, situated remotely from existing power facilities, a higher capital cost per effective electrical horse-power would, in the opinion of the Committee, be permissible if the power were used for local requirements. It may be of interest to state that recent estimates put the cost of a generating station in which coal is used at £25 per kilowatt in a station of some 100,000 kilowatts, this being just half the capital cost estimated by the Committee for the hydro-electric station. On the other hand the day when coal will once more drop to 10s. per ton is, it is to be feared, far distant.

* Excerpts from the inaugural address delivered by C. H. Wordingham, chairman, on Friday, December 9th, 1921.

MICROGRAPHS OF SANDBERG SORBITIC STEEL



TREATED × 250 DIAM. TREATED × 1000 DIAM.



UNTREATED NORMALISED × 250 DIAM. UNTREATED NORMALISED × 1000 DIAM.

It is to be hoped that the available water power in this country will be pressed into service for industrial purposes, and that it will be found possible to utilise it by means of electric transmission in those centres at which it can be most economically applied. Nevertheless, there must of necessity be a very large amount of additional power which will have to be produced otherwise than by running water.

The water powers to which I have referred are all exclusive of tidal power. Much has been written in regard to the utilisation of this source of energy, but very little has so far been done, the chief reason being the heavy capital cost involved by the engineering works necessary to enable the small and variable head and large volume of water associated with this form of power to be utilised. The Water Power Resources Committee, already referred to, in their third interim report, deal with the question of tidal power, and in particular they refer to what is known as the "Severn Scheme." This scheme alone was estimated to be capable of supplying for ten hours a continuous working load of 260,000 kilowatts, and obviously the total amount of power represented by the tide on the whole of our coast is vastly in excess of anything which we can ever hope to use industrially. The subject is a most attractive one, but the difficulties in the way of commercial exploitation are serious. It would be out of place for me to enter into the matter here in any detail, but the salient difficulties may be briefly enumerated. The head available is usually not high, and it varies periodically throughout the twenty-four hours with two maxima and two minima approximately within that period. Not only, however, is there a diurnal variation, but there is the lunar one, with the maxima and minima of spring and neap tides. The construction of turbines for these variable heads is a most difficult problem and the variability of the power, if anything like the maximum amount available at any given spot is to be utilised, means that high capital expenditure per average kilowatt must be incurred, suitable reservoir accommodation to impound the water necessarily being very costly. So long, however, as there is no inherent impossibility in the way of the utilisation of sources of power in nature, we may feel sure that it is only a question of the degree of urgency and scarcity of competing sources of power which is necessary to provide the incentive for the invention and production of suitable means of utilisation. The day of tidal power, however, certainly is not yet.

The heavy pressure brought to bear on the French by the wanton destruction of their industrial establishments by their unscrupulous and cowardly enemies, coupled with the scarcity and high price of coal, have caused them to consider most carefully all kinds of water power which they have available. Not only that derivable from the Rhone, the Pyrenees and similar sources, but even the tidal power on their coasts, where the conditions are exceptionally favourable. For example, at St. Malo the rise and fall of the tide is as much as 40ft. It is probable that there will be very large developments of hydro-electric work, and it is well worth while for the younger members of this Institution to note that the matter is being studied very comprehensively at the University of Grenoble, the classes in which are open to British students. Courses in the summer vacation were organised last year for their benefit, and will again be available this year.

Fuel Power.—No very great advance in economy can be made along the present lines of steam boilers and steam turbines, but on the other hand every 1 per cent. in efficiency achieved means improvement of some 6 or 7 per cent. on existing practice. It is true the higher economies involve substantially more expensive plant and greater complication in operating it, but it must be remembered that increased economy means less plant to produce a given output, and, therefore, the increased price per unit of plant may be much more than compensated for by the reduced total quantity to be purchased.

Internal combustion engines have been used to a considerable extent on the Continent in large stations, but they have not found favour with British engineers for many reasons, into which there is no time to enter. Should a commercially successful gas turbine be invented, capable of being made in large individual sizes, it is probable that a radical change would take place in the means of producing electrical energy and the economy would go up materially.

The ideal solution of the problem of conversion of the chemical energy of the fuel to electrical energy is probably to be found in the direct conversion by chemical means, such conversion, that is, as takes place in a primary battery. In all those batteries so far invented the fuel has been zinc; is it too much to hope that some day means may be discovered of consuming coal in this way? It cannot be said that so far there are any tangible grounds for the hope, but it is not an impossibility.

General Power Supply.—This bring me to another important point in which existing conditions in this country have a vital bearing upon ideal principles. There are two schools of thought in regard to the establishment of an electrical supply. By one it is contended that the supply should be provided and that the demand will follow; in the view of the other the demand should be met when it arises. For new countries, quite undeveloped, the former may well be the correct view, and a bold policy with liberal expenditure of capital may have magnificent results in enabling industries to be established and the new territory to be developed, while an abundant, if somewhat deferred, return on the money sunk may be anticipated. In our own country, however, with its moderate area and high degree of development, the policy involved in the first school of thought may well bring financial ruin to the speculative undertakers of supply. This country cannot be compared with virgin soil, and it is asking too much of financiers or of municipal authorities to demand that millions sterling shall be expended on the off chance that the supply of energy provided will be required. There are so many alternatives to taking the energy thus made available. Individual concerns who are able readily to establish their own undertakings may prefer to do so; may even, as in the case of collieries, find it cheaper to generate in their own stations, or, again, competitive sources of power may be found. In this country it is not unreasonable to await the materialisation of very large demands for power before providing for their satisfaction. No reasonable objection can, I submit, be taken to this view, nor is any inconvenience or delay likely to arise in consequence. For example, suppose a railway decides to electrify its lines, and, for this purpose, will require a station of 100,000 kilowatts. The electrical equipment of the railway cannot be carried out in less time than is necessary for the building of the generating station, and there is no need for the generating plant actually to be in being before the determination to electrify is come to. It is quite time to start building the generating station when it is known that the railway is to be equipped. The alternative is to expend some 2½ million pounds with no certainty that there will be any revenue to cover the interest and sinking fund thereon, a matter of, say, 10 per cent., i.e., a quarter of a million pounds sterling per annum.

Research.—A co-operative research association has important advantages. It is much more likely than any individual firm to command the confidence of Government departments and public bodies, and manufacturers are more likely to put their information and resources at its disposal. An association of the kind serves a very useful purpose in bringing together the manufacturers of raw materials, and the users, who often are at cross purposes, the one frequently not knowing the real requirements of the user, and the other being ignorant of the manufacturer's processes. Individual research may have advantages in the development of new processes, but even in this direction co-operation is likely to have beneficial results.

Obviously there are many important matters which require solution in the practical carrying out of the Association's work. Such matters as the remuneration of inventors and the proprietorship of inventions present difficult points. On the one hand, it may be argued that the man who makes the discovery or invention should benefit by it, while on the other it may be contended with equal force that those who have provided the funds for the investigation to be carried out should be the sole proprietors of the resulting discoveries when success attends the efforts of the staff. No doubt both parties should benefit, but here again the question will arise as to who is the true inventor, since seldom is an investigation carried out by a single individual. The relative shares of the various individuals of the research team must then be apportioned. Though difficult, these problems can, and will, be solved, and they are not such as to interfere seriously with the success of co-operative effort.

One very serious consideration in connection with research is the dearth of suitable men for carrying out the work. It is not so much the difficulty of training students to become efficient investigators as the fact that a very special order of mind is necessary to make an efficient research worker who will extend the confines of present knowledge. Such men are born and not made, though they are improved by training; on the other hand, it is probable that if the energies of more young men were diverted in the direction of research it would be found that a proportion of them possessed the necessary qualities which, if a different path had been chosen, would not have been developed. I commend very seriously to those who are starting on their careers a careful consideration of the adoption of research work for their life's calling. It unquestionably affords great scope for talent, is in itself extremely interesting, and may hold very substantial rewards.

National Proving House.—I have shown that there is an intimate connection between standardisation and research, the latter being a necessary antecedent in many instances to the preparation of standard specifications. There is another need which comes into existence when the work of standardising is complete, after the specification has been issued to the world, and this need has, so far, not been catered for. There is at present no recognised body in existence which can pronounce that a given article is in accordance with a certain standard, or give it a hall mark of quality. What is required for the purpose is a National Proving House so constituted as to command the confidence alike of manufacturers, purchasers and the Government.

I have long advocated the establishment of such an Institution for the electrical industry, and I am more and more firmly convinced of the benefits that would accrue from it. I am of opinion that such a Proving House should be controlled largely by manufacturers, with sufficient representation of the great engineering Institutions, advisory engineers and purchasers' interests to ensure that the whole of its work should be on a high plane and above suspicion of bias. I do not advocate that it should receive financial assistance from the Government, nor that it should be in any way under Government control, but it should have the moral support of the Government by its formal recognition.

PLANS have been prepared by the city engineer, Herre A. C. Karsten, for the improvement of communications between Copenhagen and the neighbouring island of Amager. Amager has already a population of about 100,000, and there are prospects of a further large increase. Moreover, during the last few years large factories and buildings for various Government institutions have been erected on the island, and a new mint and aviation harbour are to be added to the number of the latter. The two existing bridges, known as Knippelsbro and Langebro, are now insufficient for the traffic between the two parts of Copenhagen, and it is proposed not only to improve the present communications but also to build two new bridges to the south of the Langebro, one of which would be used for railway and tramway traffic.

Automatic Train Control.

By W. J. THORROWGOOD (Member of Council).*

THE problem of automatic train control is easy in simple cases, such as through running on straight lines, but the difficulty arises when junctions, large stations, and terminal stations have to be dealt with. It will differ according to the nature of the traffic in any area, whether local or slow, through or fast, or mixed; if the traffic is dense, such as in suburban areas, or if it be in country areas where there are few trains. The problem will vary in different countries according to the efficiency of the drivers, but if a system of automatic train control is adopted as a standard, as, for instance, was the automatic brake, it will have to be applied universally, and the whole of the running lines, sooner or later, will have to be brought under the system, as some of the worst accidents have occurred on comparatively unimportant branch lines. The system must be installed on all running lines, or the chance of missing the rare occasion when the driver passes the signal in the danger position is only too obvious.

The ultimate problems of the necessity for automatic train stops are :—

(1) The number of accidents causing injury to and loss of life and damage to property.

(2) The cost of such accidents.

(3) Will the standard system to be installed prevent these accidents, or, if not, will the greater part of them be avoided? Also whether the standard system is likely to cause other failures or accidents, or interfere adversely with traffic working?

(4) The cost of installing the new system.

(5) The additional cost of maintenance, against which would be set the value of the additional safety attained, and any advantage that may accrue as regards increased capacity of the railway lines, or increased efficiency of traffic working, and any saving of charges at present incurred.

(6) Whether other means or safety devices can be applied, which will prevent the accidents due to drivers passing the signals at danger, and also other accidents, at less cost?

(7) Whether the proposed standard system is capable of universal application?

It is recognised by all that injury to and loss of life must be prevented, if it is at all possible, as it is of no advantage to tell a man that there are only ten accidental deaths to 100,000,000 passengers who travel, if he is one of the ten. The question of cost is very important, and although the need is apparent, before embarking on any scheme for universal use, its efficiency, reliability, and costs must be considered. The magnitude of the problem from a cost point of view is illustrated by the following estimates, based on information from returns of the Ministry of Transport and general knowledge :—

Total number of engines (sixteen largest companies)	24,636
Number of engine miles run under protection of signals in Great Britain per annum	493,387,020
Number of times engines pass signals per annum (once in every 2 miles run average)	246,693,510
Number of times engines pass distant signals	98,677,404
Number of times engines pass stop signals	148,016,106
Number of miles of railway lines signalled	40,261
Number of signals (average one in 2 miles)	20,130
Number of distant signals (2/3)	5,750
Number of stop signals (2/3)	14,380
Number of accidents reported on by Ministry of Transport during 1920	23
Number of accidents that could have been prevented by train stops	6
Number of accidents that train stops could not have prevented	17
Cost of supplying and fitting apparatus to 24,636 engines for distant and stop signal warning, indication, and brake application at £100 per engine	£2,463,600
Cost of supplying and fitting apparatus for ramp and work in signal-box for 20,130 signal positions at £75 per position	£1,509,750
Total cost for complete equipment of automatic train control at distant and stop signals	£3,973,350
Cost of supplying and fitting apparatus to 24,636 engines for distant signal warning, indication, and brake application at £75 per engine	£1,847,700
Cost of supplying and fitting apparatus for ramp and work in signal-box for 5750 distant signal positions at £75 per position	£431,250
Total cost for complete equipment of automatic control at distant signal only	£2,278,950
Annual charges for distant and stop signal complete equipment of automatic train control, assuming maintenance charges at 10 per cent., interest at 6 per cent., life of plant 20 years	£754,930
Ditto for distant signal equipment only	£433,000
Failures of apparatus :	
False clear signals	2 in 10,000,000
In the safety position	5 in 10,000,000
From causes other than those due to the apparatus	3 in 10,000,000
Average number of failures	1 in 1,000,000
Number of times engines would be stopped when passing a signal when it should not have been, per annum	250
Number of additional operations or observations required from driver in passing each signal fitted with train control apparatus	3

The figures, in a great measure, explain themselves. It will be seen that it is calculated that a driver will pass an automatic train stop position with the apparatus faulty once in a million times; but, of course, it does not follow that an accident will result on each occasion, as the ordinary outdoor signals connected with the apparatus will still be carrying out their functions. It is, however, possible that a failure of the apparatus and the signal may occur at the same time. These failures may be due to the apparatus on the engine, or to the apparatus controlled from the signal-box. In either case the question arises: What action is the driver to take? The failure, if on his engine, may take place whilst he is running between stations. Obviously no lineman or outside help can get to him quickly, and it would be very difficult for him to remedy the defect without stopping his train. It seems the only thing for him to do would be to cut the whole apparatus out of work and proceed with caution. Then the safety appliances are discarded. The ordinary flagman is not available. Is the driver to go forward on his own responsibility or will he share it with the guard?

The failures likely to be met with are :—(1) Failures of apparatus on engine; (2) with apparatus on the ground; (3) when ordinary signal and automatic train control indications do not agree. In this latter case, which indication is the driver to follow? Should he treat it as an uncertain signal and bring his train to a stand, or proceed with caution, or rely on the fixed signals?

In dealing with the question of costs of installation and maintenance the advantages must be considered, but it is difficult to give their definite value. In addition to the additional safety there will be :—(1) The saving due to dispensing with fog signalling; (2) the saving due to quicker running of trains during foggy weather; (3) the increased capacity of the railway due to the shorter sections that can be worked to safely.

The cost of the apparatus and fitting will depend upon whether a single standard system is used and whether it is installed in small or large quantities. If the orders are given out for long lengths—say, 200 or 300 miles at a time—the figures in the estimate can be materially reduced. But in looking for economy nothing must be done to make the system less efficient, so that it might lead to a driver being in a state of false security.

There will still be a number of classes of accident that could not be prevented by automatic train stop apparatus, such as :—

(1) Deformation of road, due to spreading, sudden heat, or other causes.
(2) Drivers travelling too fast round curves.
(3) Signalmen's errors.
(4) Defect of vehicles, axles breaking.
(5) Buffer stop collision, unless a positive continuous system is used.
(6) Obstructions on railway.
(7) Broken rails.
(8) Errors of drivers after they have passed the distant signal and taken control of their train.
(9) To defects in the new automatic train control apparatus to be installed.
(10) To failures of the automatic brake apparatus.
(11) Other causes.

When considering a system it must be borne in mind that many of the requirements asked for, automatically to control trains, are based on the conditions applying when fog is prevalent; in fact, the idea of automatic train control arose, in a large measure, from the requirements during foggy or snowy weather, when, of course, the benefits of control are most appreciated; but it is well to pause and consider how far the necessities of foggy weather during, say, three months of the year, shall be made to apply in fine weather during the remaining nine months. It would not be advisable to have two modifications of a system on the engine, as the difficulty and danger in changing from one to the other would be very great, even if it were possible.

The principles upon which communication is now obtained between the signalman and the driver in the cab of engine are many and varied, such as :—

(1) Mechanical: Contacts fixed and movable; trips movable; ramps fixed and movable.

(2) Electrical: Continuous contact with third and fourth rails; continuous contact with overhead wires; intermittent contact with ramps; track circuit; high-frequency currents on the track; high-frequency currents on the engine; wireless telegraph systems; electro-magnetic system.

(3) Magnetic: Magnetic system; insulated rails.
(4) Secret systems, where details are not disclosed.
(5) Detonation explosion.
(6) Systems have been devised on the intermittent and continuous indicating principles.
(7) Systems depending on time element devices and the speed of trains.

Before deciding to adopt any automatic train control system on a railway the question should be asked if provision has been made for ordinary accidents, for obviously it is not economical or advisable to install a more or less complicated apparatus to meet the case of a few possible accidents, when a simple apparatus, at much less cost, can be installed to prevent the common or more frequent accidents, in such cases as on a single line, where the tablets are not interlocked with the starting signal, or train waiting track circuits at places where the signal is not in full view of the signalman. The automatic train control system is called for in very great measure on account of the drivers, much as the electrical and mechanical interlocking was brought into use on account of the signalmen; but it must be borne in mind that other classes of accidents occur on railways, and their importance should be compared with those of the drivers and signalmen, with a view to prevent them.

However, the accidents caused by drivers passing signals at danger and the resulting consequences are so serious that it is only too obviously necessary to endeavour to find a remedy for this class of accident.

The real problem is to determine whether a comparatively simple system will meet the known circumstances, wholly or only partially, and if the latter, whether it would be justifiable to incur the expense of installing a partial remedy, or to go further and provide a more complete system, or even a complete system, if it best met the lamentable loss of and injury to life. To obtain what is necessary at the least cost is a problem common to all schemes. Visible and audible indications are given in the cab of the engine to tell the driver whether the distant signal or the stop signal—if included in the system—is in the clear or danger position, in the Great Western Railway system, North-Eastern Railway cab signalling and other systems. In the Great Western Railway system and others there is also an application and release of the brake if the distant signal is in the "on" position. The audible indication for "clear" is different to that for "danger." In some cases audible indications and brake application and release only are given, with a distinctive sound for the clear and danger signals.

The question is raised as to whether a cab signalling system, without any interference with the brake, is sufficient. This meets the locomotive engineers' objection that the brake or control of the train should not be taken out of the hands of the drivers, but the vast majority of schemes proposed provide for an application of the brake and a release on passing a distant signal in the "on" position, and the general consensus of opinion is distinctly in favour of some kind of brake application.

If it is decided to provide a system in which a positive stop application of the brake is made when a driver passes a stop signal in the danger position, many questions have to be considered before its efficiency and its measure of safety can be determined. The more that a system does, almost without exception, the apparatus is more complicated. The difficulty of maintaining the mechanism is much increased when it is complicated. The liability to faults and failures, which must of necessity be prevented, is greater. Simplicity of apparatus and appliances, providing they are strong, is a very great advantage.

If an automatic train control system is adopted as a standard and is applied generally, its efficiency, reliability and freedom from faults and failure will be of the very utmost importance, as will also be that of the reliability of the automatic brake apparatus, and not less so the necessity for the signalman to work absolutely correctly, as if the driver is relying on the automatic train control system, which he will do, with justice after a time, and a fault or failure of either the automatic train control device, the automatic brake, or the signalman occur, the results of the accident are likely to be more serious than they would be under present circumstances.

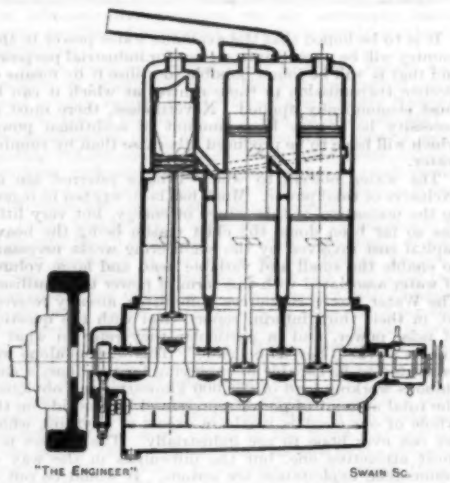
An important problem to be decided when introducing a new system is as to what is a satisfactory test of the system. A test with a series of set conditions may be favourable to the apparatus; but the set conditions would, in all probability, be quite different from those met in practice, or a number of conditions may be omitted. It would appear that a trial in service over a sufficient period is the only satisfactory method of test to apply.

* The Institution of Railway Signal Engineers (Incorporated).—Abstract. July, 1921.

A Valveless, Gearless Engine.

WE are informed by a correspondent that an internal combustion engine embodying some novel features of design has just been constructed for the inventor at the G.D.S. Works, Manchester. The bench tests have been remarkably promising, and the engine will shortly be installed in a chassis, and the car will be used for demonstration purposes. The engine is the invention of Mr. W. F. Wege, an Australian engineer.

It is a "two-stroke," built with three (or multiples of three) cylinders. Other than the ports, there are no valves, there is not a single gear wheel in the engine, and all cams, shafts, tappets and springs, and even the timing gear, are eliminated. The moving parts consist only of the crank shaft, pistons and connecting-rods. The experimental engine is rated at 10 horse-power, and on bench test has developed 26 horse-power. The cylinder blocks, as shown in the accompanying cut, are designed with two diameters having a common piston, which is connected to the crank shaft in the usual way by a connecting-rod. The lower or pump chambers of the cylinders are connected



"THE ENGINEER" SWAIN SC.

THE WEGE VALVELESS, GEARLESS ENGINE

by a common manifold inlet, which in turn is coupled to the carburetter.

The cycle of operations is as follows :—On the down stroke of the piston a vacuum is formed in the pump chamber, and at the end of the stroke the exhaust port in the explosion chamber is uncovered. So also is the inlet port of the lower chamber, into which the gas then enters. On the return stroke the charge is compressed, and when the transfer port is opened, is passed into the explosion chamber of the adjoining cylinder. In like manner the second cylinder feeds the third, and the third transfers its charge to the first.

The engine has been designed to meet conditions existing in Australia, which call for a car light but strong, with a good clearance and a wide track, but above all, with a power unit simple of construction. Motoring in Australia soon carries one beyond the reach of repair shops, and what may have to be done by the wayside to car or engine must be as simple as possible. When the Wege engine has passed through the strictest of tests here, on the road and in the laboratory, the company intends to build in Australia for Australia.

Tanks and Chain-Track Artillery.*

By L. A. LEGROS.

No. III.†

THE ESSENTIAL DATA FOR DESIGNING CHAIN-TRACK VEHICLES.

(1) *Gearing with the Ground (Tangential Effort).*—The link of the chain track is usually formed with two projections which act as teeth and gear with the slabs of earth between them. Resistance to traction can therefore be measured in proportion to the area of these slabs of compressed earth imprisoned between the consecutive projections on the chain track. As soon as the chain track begins to rise the compression of the earth and the resistance to shearing diminish; the area of the front and central part of the chain track in contact with the ground can therefore only be taken into account in determining the effective resistance.

On grass land the tangential resistance under normal

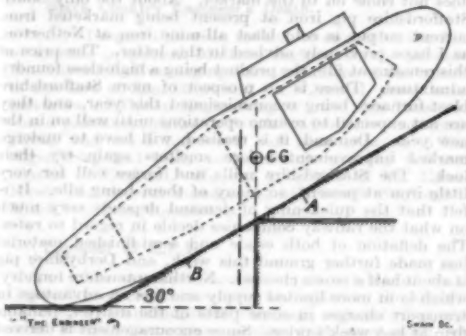


FIG. 28

conditions of loading may be taken as 3 kilos. per square centimetre (45 lb. per square inch), but on clayey soil, as soon as shearing commences, the slabs fill the spaces formed between the projections on the chain links, thus producing a uniform smooth surface which can slide indefinitely on the ground. For crossing such ground it is necessary to use detachable spuds (called grousers in America), which, by increasing the depth of hold on the ground, enable the necessary resistance to be obtained. According to the results of experiments made with agricultural tractors it appears that spuds of good shape may transmit a load of 3 to 5 kilos. per square centimetre of the vertical area (45 lb. to 75 lb. per square inch). Marshy ground so soft as to require a reduction in the insistent load is dealt with by an increase in the area of contact

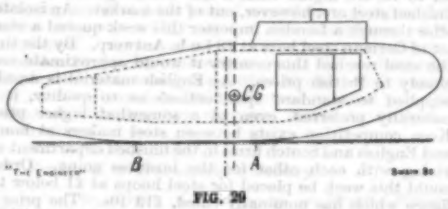


FIG. 29

of the chain track; this is obtained by widening the chain track and consequently enlarging the slabs of earth which resist shearing. As steep gradients are not to be feared on such ground, the use of spuds is unnecessary.

(2) *Insistent Weight, Load per Square Centimetre (or per Square Inch).*—It is essential that a tank should be able to travel over ground over which not only cavalry can pass, which requires a vertical resistance of the ground amounting to 2 kilos. per square centimetre (30 lb. per square inch), but also infantry, which only requires a vertical resistance of about 500 to 600 grammes per square centimetre (7.5 lb. to 9 lb. per square inch). It is even required that they shall go where infantry cannot pass; it may be mentioned that some American chain-track tractors have been modified in certain instances by widening the chain track so as to be able to cross marshes capable of carrying a load of only 150 grammes per square centimetre (2.25 lb. per square inch).

The difficulties of traction are still further increased when snow is in question. It is interesting to note that the ski runner requires a vertical resistance of only 50 grammes per square centimetre (0.75 lb. per square inch), whereas a man walking on snow shoes exercises a pressure of about 100 grammes per square centimetre (1.5 lb. per square inch).

The carrying surface increases considerably with the depth of sinkage, but not in the same proportion with the caterpillar as with the wheel. An easy method exists for increasing the bearing surface by about 30 per cent., if the nature of the ground so requires, by the use of chain links widened on the outer side so as to form a cantilever projection. Non-symmetrical chain tracks were used in several instances on the Saint-Chamond and English tanks.

(3) *The Power per Ton.*—The power per ton of commercial tractors varies from 8 to 15 horse-power. In the case of the tank the weight is increased by the armouring, and the running conditions are rendered still more difficult because the tank is required to climb gradients which may be as steep as 45 deg. In such a case the measurement of the gradient must be taken, for calculations relating to the tractive effort, as the sine of the angle instead of the tangent; the necessity for doing this does not occur

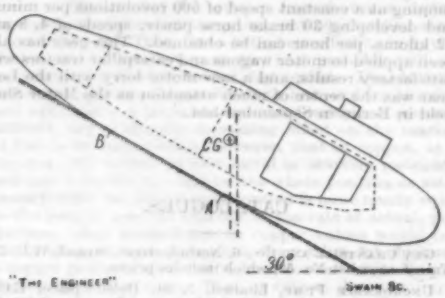


FIG. 31

on the steepest gradients found on ordinary roads, and still less on railways.

The maximum effort of traction of agricultural and commercial chain-track tractors generally amounts to from 35 to 60 per cent. of the weight. This figure reaches 80 to 100 per cent. in the tanks, permitting them to climb very steep gradients which in some cases have even exceeded 45 deg.

(4) *Limiting Dimensions.*—The width and height of the tank are limited by the requirements that on the one hand the vehicle must be able to run on roads, and on the other hand that it must be capable of being carried by rail on a flat-topped wagon. The height of the tank is not only limited by the loading gauge, but also by the necessity for keeping the visibility of the vehicle as low as possible. Only in a few instances have the tanks exceeded 2.50 m. (8ft. 2in.) in height.

(5) *Speed.*—The speed of the commercial tractor varies in the case of heavy tractors from 1.7 to 5.5 kilom. (1 to 3.5 miles) per hour; in the case of fast tractors from 2.6 to 12 kilom. (1.5 to 7.5 miles) per hour.

The first English tanks (Marks I. to IV.), which were very heavy, had a speed of only 1.2 to 6 kilom. (0.75 to 3.7 miles) per hour; the Schneider tanks had a speed of 2 to 6.7 kilom. (1.2 to 4.2 miles) per hour; and the Renault tanks 1 to 7.8 kilom. (0.6 to 4.8 miles) per hour. The fast English "Whippet" tanks (medium Mark A) took more account of the principle formulated by Colonel Crompton that "real armouring is speed"‡, and attained a speed of 2.4 to 13.5 kilom. (1.5 to 8.3 miles) per hour.

(6) *The "Effectiveness," that is to say, the Immunity from being Struck by Enemy Fire.*—As a base of comparison between designs, Colonel Crompton laid down the principle that the "effectiveness" of a tank is a function of the square of its speed divided by its height"; this principle has been largely justified by the changes of design in the actual tanks produced, but it could be reduced to definite terms by experiments in firing at targets of the form and profile drawn across uneven ground.

(7) *Control and Steering by One Man.*—Attention has already been drawn above to the fact that the control and braking of the tank should be in the hands of one man only; this is essential for rapidity and safety in manœuvring the ordinary automobile, and is still more necessary with the extremely sharp turnings that can be made with the tank.

(8) *Armouring.*—The thickness of the armour should vary, as on battleships, according to the portion of the tank to be protected and according to the angle which the surface presents to enemy fire. At the commencement it was found that a thickness of armour of 10 mm. would stop the German bullet, but it was soon found that at short range and with the reversed rifle bullet, as used by the Germans for this object, a thickness of 11 mm. and even 12 mm. (0.43in. and 0.47in.) was barely sufficient.

(9) *Position of the Centre of Gravity.*—The position of the centre of gravity is of great importance in determining the ability to climb obstacles. A high position of the centre of gravity requires a greater inclination of the tank before equilibrium is reached on the edge of the obstacle—Fig. 28. This effect may also be produced by a lower position of the centre of gravity, but more to the rear of the tank, which brings it on the same critical line; there is another reason for keeping the centre of gravity towards the front of the tank; in every automobile vehicle, when running forward, there is a couple exercised by the motor and increased in magnitude by the gear between the crank shaft and the periphery of the wheel gearing with the chain track, the effect of which is to produce a virtual displacement of the centre of gravity towards the rear—Fig. 29. It will be remembered that in the first automobiles, when climbing hills, the front wheels sometimes lifted and that the vehicle could turn over about the back axle instead of progressing. It must not be forgotten that in descending gradients this couple changes its sign, and that a position of the centre of gravity too far forward would involve the lifting of the rear of the car and cause turning over forwards—Fig. 31.

(10) *The Curve of the Chain Track in Contact with the Ground.*—The first chain tracks made in France were based on the Holt system, with spring suspension.

The English tanks had no spring suspension; the first tank had a very flat and very long bearing surface on the ground, but the later marks took a more oval form, with very short, straight lengths and gradual changes of curvature. Although this form does not give the minimum sinkage, it has numerous advantages for control and steering.

(11) *The Path Traced by a Point on the Caterpillar.*—

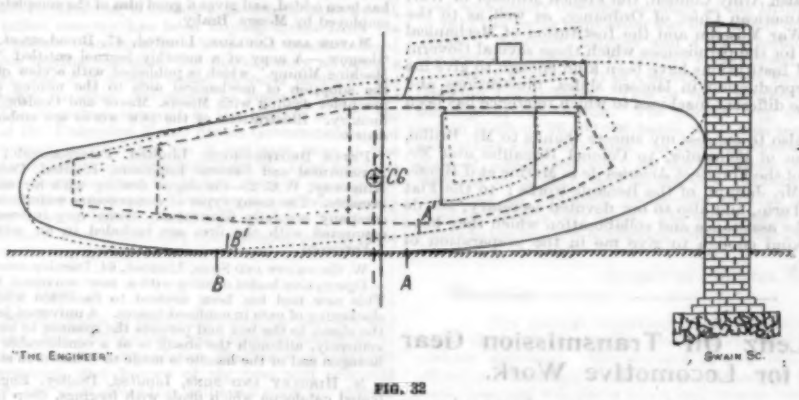


FIG. 32

This question is of interest in considering the ability of the vehicle to climb projecting obstacles.

In the case of the Holt type of chain track—Fig. 30—with equal semi-circular ends, any point follows a path which consists in two cycloids connected by the common tangent of a length equal to double that of the straight part of the chain in contact with the ground.

In the case of the Renault type of chain track having its ends formed as two circles of different diameters, the curve takes the form of two portions of different cycloids connected by a common tangent.

When the form of the chain track is arbitrary the curve must be determined graphically.

A study of these curves will enable one to take account

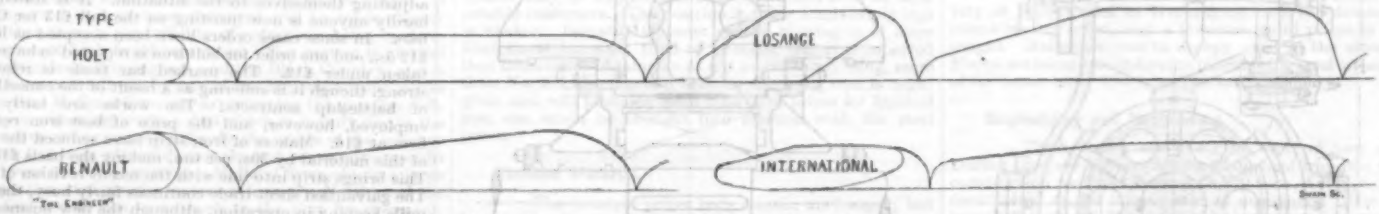


FIG. 30

of the variations in the propulsive effort against an obstacle and in the resistance offered by the ground.

In the case of a tank in contact with a vertical obstacle—Fig. 32—the point A of the frame becomes displaced to A^1; the chain track remains in gear with the ground, while the point B at the front climbs to B^1. The resultant of the shearing effort on the ground and of the weight of the tank tends to overturn the obstacle.

(12) *Distance Run.*—The distances actually run by tanks on roads and on the ground are widely different; according to the observations made by General Estienne during the war, out of a total distance of 500 kilom. run by a tank, only 30 kilom. were run off the roads. Now, running on the road wears out the chain track much more than running over soft ground.

Numerous trials and experiments have been made in France, in England, and in America, to fit the vehicle

* Abstract of paper read before the British Section of the Société des Ingénieurs Civils de France. September, 1921.

† No. II. appeared December 9th.

‡ This expression was also adopted by Lord Fisher, Chief Lord of the British Admiralty, in regard to the armouring of battleships.

either with wheels or with removable chain tracks. Up to the present no system has shown distinct superiority.

POSSIBLE IMPROVEMENTS IN THE CHAIN TRACK.

The chain track with steel links wears rapidly on the roads; it runs under extremely bad conditions. In order to obtain overlapping of the links, it has been necessary to place the pin joints with their centres very near to the ground in a position in which no casing can protect them against dust, water or mud. This disadvantage may be somewhat reduced by the abundant use of thick oil as practised in America.

Tests of belts made in England in 1915 by Tritton and Wilson did not give the satisfactory results which were expected. This system, however, had already been investigated in Russia by Mr. Kégresse for the running of cars over snow, and he had attained satisfactory results from belt tracks. Further trials made in February, 1921, in France, showed that the Kégresse flexible belt track enabled a car to be run, not only over snow, but also over sandy ground, even over steep sand, and on marshes.

The hammering of hard and particularly of iron-shod wheels on the road has always been the greatest enemy to high speed in traction. Speed on the road has, moreover, been increased by the use of rubber tires, and this has been still further increased by the substitution of the pneumatic for the solid tire.

It is obvious that chain-track traction will find its future to lie in improvements to be obtained from a more yielding contact and more elastic springing than exists at present. If these improvements follow with the same rapidity as in the case of the automobile, we may in the near future see light cars capable of being run at will at a high speed on the slopes of mountains, across fields, over snow, and on the sand of the desert, as well as on a good road; for, as General Estienne has said (translated): "The appearance on the battlefield of chain-track mechanical vehicles was an event the importance of which equals that of the invention of gunpowder."

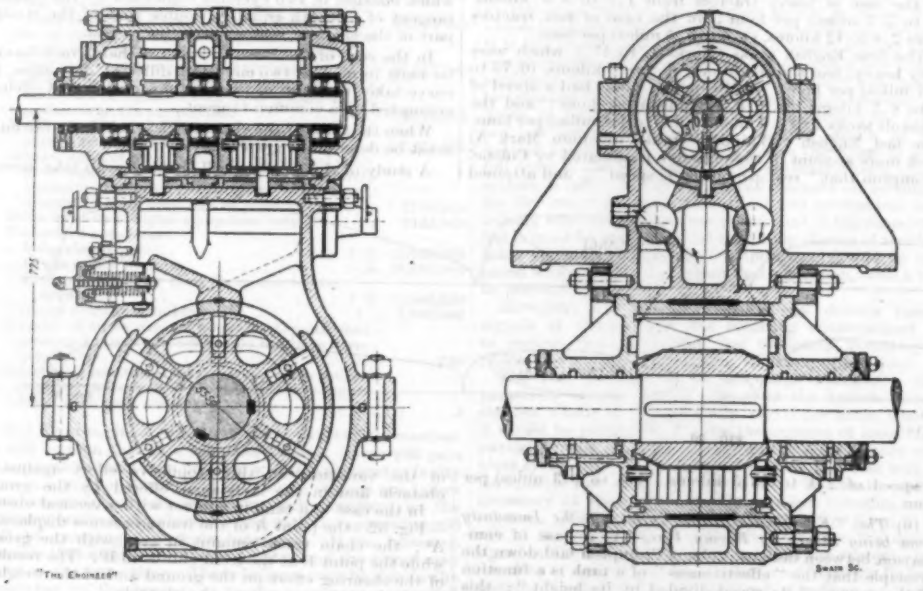
In this paper I have endeavoured to pay just tribute to the engineers whose fertile brains have conceived and elaborated the details, the creators of the tanks and the adaptors of the chain track to carrying artillery, and to express the admiration and thanks of all, particularly to Colonel R. E. B. Crompton, of England, Mr. William Strait, of the United States, to General Estienne, Mr. E. Brillié and to Colonel Rimailho, of France, with the assurance of our profound gratitude.

Before concluding, I wish to express my sincere thanks to the British Army Council, the French Minister of War, and the American Chief of Ordnance, as well as to the Imperial War Museum and the Institution of Mechanical Engineers for the permissions which these several Governments and Institutions have been kind enough to give me for the reproduction in lantern slides, illustrations and films of the different machines to which reference has been made.

I wish also to express my sincere thanks to Mr. Brillié, of the firm of Schneider, to Colonel Rimailho and Mr. Berthier, of the Forges et Aciéries de la Marine et d'Homécourt, to Mr. Jannin, of the Renault works; to the Fiat works of Turin, and also to our devoted secretary, Mr. de Dax for the assistance and collaboration which they have all been kind enough to give me in the preparation of this paper.

The Lenz Oil Transmission Gear for Locomotive Work.

THE Lenz system of oil transmission, which has been in use for some years for small powers, seems to offer an interesting solution to some of the difficulties which have to be faced with the electric or Diesel locomotive. The illustration given shows a gear for 200–300 brake horse-power transmission now under construction for the Prussian railways, with a view to finding out whether this form of drive will enable improvements to be made in the design of electric locomotives. The gear, as will be seen from the drawing, which we copy from the V.D. I, consists essentially of a pump and rotor with axes at right angles, mounted in a common housing. The pump is of the multi-stage rotary shutter type, and the force of the oil stream and the consequent rate of power and speed transmitted is determined by the introduction of one or more stages, or a combination of stages. The motor driving the pump is a single-phase induction motor of the A.E.G. type, with characteristics closely resembling the conditions which obtain when a Diesel engine is used, so that useful information may be gathered as to the probable performance of a Diesel locomotive with the same gear. This electric locomotive will be placed on one of the mountain railways early in the new year, with a running programme approximating to 100,000 kiloms. in the year, which will enable test results to be rapidly ascertained. A further experimental small Diesel locomotive has been constructed, with a three-cylinder Benz-Diesel engine, driving direct through a Lenz transmission gear. With the engine running at a constant speed of 500 revolutions per minute and developing 30 brake horse-power, speeds of 4, 8 and 12 kiloms. per hour can be obtained. This gear has also been applied to motor wagons and caterpillar tractors with satisfactory results, and a new motor lorry with the Lenz gear was the centre of much attention at the Motor Show held in Berlin in September last.



LENZ OIL TRANSMISSION GEAR

CATALOGUES.

GUY CHANTRELL AND CO., 6, Norfolk-street, Strand, W.C. 2.—Transformer list No. 52, which includes prices.

UNCHOKABLE PUMP, Limited, 3, St. Helen's-place, E.C. 3.—Illustrated booklet, entitled "Points on Pumping Solids."

STANTON IRONWORKS COMPANY, Limited, near Nottingham.—October list of cast iron pipes in stock, available for disposal.

SULLIVAN MACHINERY COMPANY.—Bulletin No. 77B deals with the Sullivan angle-compound power-driven air compressors. The pamphlet is fully illustrated.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, East Pittsburg, Pa.—The September issue of "Contact," which is specially devoted to the Westinghouse Mazda lamp.

WALKER WESTON COMPANY, Limited, Empire House, 7, Wormwood-street, E.C. 2.—Pamphlet No. 6 deals with the North circular arterial road. The Walker-Weston system of reinforcement has been carried out by the Middlesex County Council in conjunction with the Ministry of Transport.

FREDK. BRABY AND CO., Limited, Petershill-road, Glasgow.—A new issue of Braby's "Handbook for Architects and Engineers." This book has been revised and much additional material included. A new collection of views of various departments has been added, and gives a good idea of the complete equipment employed by Messrs. Braby.

MAVOR AND COULSON, Limited, 47, Broad-street, Mile End, Glasgow.—A copy of a monthly journal entitled "M. and C. Machine Mining," which is published with a view of promoting the adoption of mechanical aids to the mining of coal. A pamphlet dealing with Messrs. Mavor and Coulson's new iron-foundry. Illustrations of the new works are embodied in the article.

PETER BROTHERHOOD, Limited, Peterborough; branch of Agricultural and General Engineers, Limited, Central House, Kingsway, W.C. 2.—Catalogue dealing with air and gas compressors. The many types of compressors manufactured by the company are fully illustrated. Some very interesting details connected with the firm are included in an article entitled "Foreword."

W. CROCKATT AND SONS, Limited, 64, Darnley-street, Glasgow.—Descriptive leaflet dealing with a new universal box spanner. This new tool has been devised to facilitate screwing up or slackening of nuts in confined spaces. A universal joint connects the shank to the box and permits the spanner to be turned conveniently, although the shank is at a considerable angle. The hexagon end of the handle is made to Whitworth standard.

N. HINGLEY AND SONS, Limited, Dudley, England.—Illustrated catalogue which deals with forgings, drop forgings, and general smiths' work. Messrs. Hingley's experience in these classes of work is well known. In 1850 the first steam hammer in the Midland counties was erected at Netherton Works. It worked for over thirty-seven years without a breakage, and in this time made about 10,000 tons of forgings. Since 1850 the firm has been occupied in the production of forgings of all kinds and particularly wrought iron forgings. Up to the time of the war the forgings manufactured were used by Messrs. Hingley in their other businesses. During the war the special calls made on the resources of the firm necessitated increase of forging capacity, consequently enabling the company to undertake a large amount of general work, now that war contracts have ceased. The catalogue has some excellent illustrations and is very well printed.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Staffordshire Pig Iron Prices.

THE manufacture of foundry pig iron was resumed this week at the furnaces in North Staffordshire. The new price for superior foundry qualities was fixed at £6 5s. delivered, or £5 15s. at furnaces. This compares with £4 17s. 6d. to £5 at furnaces for Derbyshire No. 3 foundry and £4 15s. for Northamptonshire No. 3. The production of part-mine foundry iron and forge iron in South Staffordshire is still delayed, none of these furnaces having been blown in since the coal strike. In saying this I except the plant of Alfred Hickman, Limited, where three out of five furnaces are blowing, since the whole of that firm's production is used up in its own steel works and does not come on to the market. About the only South Staffordshire pig iron at present being marketed from current output is cold blast all-mine iron at Netherton, as I have previously advised in this letter. The price of this remains at £15, the product being a high-class foundry admixture. There is no prospect of more Staffordshire blast-furnaces being recommissioned this year, and they are not expected to resume operations until well on in the new year. Demand, it is realised, will have to undergo marked improvement before smelters again try their luck. The Staffordshire mills and forges call for very little iron at present, so many of them being idle. It is felt that the quickening of demand depends very much on what the railway companies decide in regard to rates. The deflation of both crude and semi-finished material has made further ground this week, and Derbyshire pig is about half a crown cheaper. Northamptonshire foundry, which is in more limited supply and has an advantage in transport charges in some parts of the district, remains firm at last week's price. Some encouragement is derived from the reduction in the imports of Belgian pig iron, which for November were 15 per cent. below those of October. The latest quotations for this material have been above the figure at which iron could be bought from local sources. It is believed here that future imports will be restricted to the fulfilment of old contracts.

Exit Foreign Steel.

In the finished steel department the steel makers are out for business, and are determined to exclude foreign steel. Very little of this is now offered, and the prices are not attractive. Many foreign contractors have failed to keep their engagements regarding time delivery, and a good deal of business has therefore been cancelled. This does not, of course, help the foreigner in his endeavour to secure business in Birmingham. Most Belgian quotations, owing to the movement of exchange rates, are from 5s. to 7s. 6d. higher than a few weeks ago. Billets and finished steel are, however, out of the market. An isolated offer through a London importer this week quoted a small lot of German steel bars at £8 f.o.b. Antwerp. By the time the steel reached this country it would approximate very closely to British prices. As English material is usually supplied to standard specifications as to quality, it is naturally preferred, even at a somewhat higher price. Keen competition exists between steel makers at home, and English and Scotch firms in the finished department are vieing with each other for the business going. Orders could this week be placed for steel hoops at £1 below the figure which has nominally ruled, £13 10s. The price of boiler plates has been reduced from £16 to £14 10s. Welsh steel bars can be bought at £7 15s. delivered in this district. Billet makers are exceptionally well off at the moment, and can command £8 to £8 10s. according to quality. Tube strip can be obtained as low as £11, at which figure it is stated not to be a profitable line.

Manufactured Iron.

There is very little being done in the bar iron trade. Competition for the small orders going gives associated makers who are loyal to the £13 basis for unmarked bars a very poor chance of participating, and tension has resulted. Owing to the undercutting of unassociated houses, which still continues, there is a disinclination on the part of other organised bodies to make official declarations of minimum prices, but they are adjusting themselves to the situation. It is stated that hardly anyone is now insisting on the full £13 for Crown bars. In some cases orders have been accepted as low as £12 5s., and one order for bolt iron is reported to have been taken under £12. The marked bar trade is relatively strong, though it is suffering as a result of the cancellation of battleship contracts. The works are fairly well employed, however, and the price of best iron remains firm at £16. Makers of iron strip have reduced the price of this material by 30s. per ton, making the basis £13 10s. This brings strip into line with the recent revision of bars. The galvanised sheet trade continues fairly busy, the local mills keeping in operation, although the new business has not justified the re-starting of idle plant.

Engineering.

A little improvement is manifest in engineering, especially in the steel department, railways having given out orders for certain details for rolling stock, and certain large foundries are operating four days a week. Those concerns which specialise on motor car work are also busier. A little increase is noted, too, in the number of structural contracts in the market, though the tonnages are small.

Cheaper Power for Birmingham.

A substantial drop in the price of gas is one of the boons the new year will bring Birmingham manufacturers and users of gas power. In July an increase of 8d. per thousand feet was imposed [as a special measure necessitated by the enormous loss inflicted on the gas

undertaking by the strike. The revenue due to it has not been as large as had been hoped, owing to the acute trade depression, and until the meter readings at the end of the month have been completed the extent to which the increase has met the special expenditure due to the coal strike can only be an approximate estimate. In view, however, of some small savings on coal and other raw materials and the substantial drop in the wages bill, the Committee feels itself justified in recommending to the City Council that a reduction of price, the first for many years, shall be made. The exact amount has not yet been decided, but it will be in the neighbourhood of sixpence. It is thought probable that this reduction will be accompanied by adjustments so as further to cheapen bulk supplies to manufacturers. Many authorities are making concessions of this sort to large trading concerns, and Birmingham manufacturers find themselves at a considerable disadvantage in consequence. The Committee is credited with the desire to bring the price of supplies for trade purposes more in proportion to the cost of production and supply than at present, in the belief that it will assist in the revival of Birmingham trade.

Black Country Engineer's Death.

I regret this week to have to announce the death of another prominent Midland engineer in the person of Mr. Oliver Howl, managing director and one of the founders of the firm of Lee, Howl and Co., Limited, pump manufacturers, of Tipton Engineering Works. Mr. Howl, who was a prominent figure in South Staffordshire engineering circles and much esteemed, had been engaged in large engineering and other undertakings in many industrial centres of England. He was a brother of Mr. Edward Howl, the general manager of the South Staffordshire Mines Drainage Commission.

Payment of E.P.D.

The intended concession just announced by the Chancellor of the Exchequer with regard to the affording of relief to manufacturers who have not yet discharged their liability for excess profits duty meet with wide approval in Midland manufacturing circles, and at a recent meeting of the Midland Branch of the National Union of Manufacturers at Birmingham, a resolution was passed thanking Sir Robert Horne for his "concession to the needs of industry by the funding of arrears of E.P.D., which will materially assist trade and help in the problem of unemployment."

Birmingham and the Engineers' Agreement.

Master engineers of the Black Country and the Midlands are rather worried at the moment as to the outcome of the ballot of the engineers on the overtime question. Although the Executive Council of the Amalgamated Engineering Union strongly advises members to vote for the agreement on freedom of management and overtime recent provisionally arrived at with the Engineering and the National Employers' Federation, a meeting representative of 20,000 engineering members of the A.E.U. in the Birmingham area have passed a resolution pledging themselves to vote solidly against the acceptance of the employers' interpretation of the agreement. There is considerable feeling in this area among the workers on the employers' view, which is stated to be that any firm requiring overtime can have it performed without prior consultation with the shop stewards, works committees, or trade union.

Future of a Warwickshire Colliery.

The threat of a stoppage at Messrs. Stanleys' Nuneaton pit as a result of the men's refusal to accept a 10 per cent. reduction in wages which the owners state is necessary if the pit is to continue working, became a realised fact on Monday, when some 1500 employees were thrown out of employment. The men's point of view is that it would be disloyal to the other miners in the county to accept the colliery owners' proposal. At the same time they express their willingness to do everything possible to help the officials in working the pit to make it successful. Negotiations between the owners and the men are going on

The Railway Rates Question.

Although the general managers of the principal railway companies have now fully considered the question of railway rates, up to the time of writing no announcement has been made as to the course they intend to adopt. It is expected that an announcement will be made shortly and that there is a possibility of reductions being made in the present high freightage rates. This matter is of vital importance to Birmingham and the Black Country, and it has been pointed out by one of the big engineering works here that Midland firms are experiencing the greatest difficulty in obtaining work, a fact which is mainly due to the excessive railway rates. Nearly the whole of the tonnage which has been placed during the last six or nine months has gone to the coast firms. Midland firms obtain a large proportion of their raw materials from the North, and the finished article has to go back to the port for shipment. They therefore have against them a very heavy incoming rate and a very heavy outgoing rate, which entirely prevents successful competition.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

REPORTS of signs of improvement in trade are appearing constantly, and one might think that there was some substantial basis for them, but the feeling in this city amongst business men is distinctly pessimistic. All these reports are consistently ridiculed, and hence one is compelled to believe that in this district at any rate there is no forward movement as yet. No doubt we shall be able to judge better of the value of the reports after the first fortnight in January, but it must be admitted that vague intimations of improvement are not so convincing on the one hand as are the known conditions of the commercial and industrial world on the other hand. The great restriction of all the markets as a result of world poverty is a fact which cannot be ignored. There are many people—and some of them in very prominent places—who still believe that the destruction of prosperity in one country is beneficial to the trade of another country; that is, they have never grasped the truth of the solidarity of commerce and industry; they fail to see that they cannot injure a customer without also injuring themselves.

Metals.

The market for copper has shown a certain weakness after the slight improvement which set in about a fortnight ago. There was a little better feeling in buying circles, but it has not gone far, and probably will not now return until after the holiday period. The statistics are certainly more favourable both here and in America, and apparently a large absorption of scrap has occurred without any distinctly depressing effect on the market. It has to be remembered, however, that in copper, as in pig iron, the output of new metal is severely restricted, and one is unable to consider the whole position as satisfactory until the rate of consumption is more nearly equal to the rate of possible, and not to the rate of actual, production. Any distinct rise in copper values would certainly bring more producers into the market, for obviously a copper producer does not remain content while his production is in abeyance. This, of course, does not imply that prices are likely to go lower, but merely that every rise in the price is likely to be met by an increased supply. The actual demand for copper in this country seems to be rather better than it was a month ago, and it is noticeable that when one talks to merchants and to scrap metal dealers their tone is more cheerful; but it would probably be rash to assume from this that the time to buy copper for forward requirements had arrived, unless the buyer is prepared to hold for a long time. One cannot help thinking that the revival in the copper trade is hindered by the high prices still charged for manufactured copper and brass. The excuse for these prices based upon the enormous costs of manufacture is gradually becoming less effective, and it is quite time that all those manufacturing prices were reduced. The market for tin has maintained a very firm appearance, although there are some who think that the rise has now gone far enough for the present. There is no doubt that the tin-plate trade, both in Great Britain and in America, is taking a good deal more metal, and the latter country has been buying direct from the East at prices considerably above the market here. Should this buying continue, the market may advance a little more, but if it should cease, there is probably not enough trade in other directions to sustain the recent prices. The uncertain element in the market is still the attitude of the Federated Malay States Government; but the inducement to liquidate tin is less now than it was before the new loan was successfully floated. Lead has been steady after the recent set-back, but there is no sign yet that prices will come back into the ordinary relationship which used to exist between lead and spelter. The latter market remains very quiet, and the changes taking place in it are quite negligible.

Foundry Iron.

The condition of the market here for foundry iron is very quiet, but nothing else was expected this week or next. There is now an expectation that railway rates will soon be reduced, and buyers of pig iron will probably wait now to see what effect this will have upon the current prices. It seems to be assumed that a further cut in the prices will be made if any considerable reduction in railway rates is obtained; but it does not follow that cheaper iron will bring any revival to the Manchester foundry trade. The orders now coming in for castings are very few, and even if the railway rates are reduced to within 50 per cent. of the pre-war rates—and that is as much as can be expected—Manchester will still be seriously handicapped as a centre for castings. Of course, there is a considerable local consumption in the engineering trades of the district, but for outside business things will remain difficult. It is said that two more furnaces, lately on basic iron in the Cleveland district, are to be transferred this week to foundry iron, simply because the steel-making pig is no longer wanted. This may help to get the Cleveland price down again, but it is difficult to see how it will affect the Manchester local trade, although Manchester merchants may be able to sell more Cleveland iron to their outside customers. The position in other kinds of pig iron is weaker; hematite is easier on the blowing-in of more East Coast furnaces, tired of idleness, and it is reported that hematite is obtainable at not much, if anything, more than No. 3. The demand here for forge pig iron is negligible, and will probably remain so until prices for finished iron can again be brought into relation with the steel prices.

Finished Material.

The nominal prices here remain unchanged, but business is slow, and there are constant reports of lower rates beng accepted in other districts. Angles at £9 10s. and joists at £9 per ton do not seem to be at all extravagant; and in fact, compared with the prices of semi-steel they are low; but buyers are not now in a mood to buy anything, no matter what the price may be.

Scrap.

Both steel scrap and wrought scrap are dull and without any inquiry. Some dealers are now considering whether it is not worth while to accumulate large stocks of steel scrap, which, according to report, can be obtained at about 50s. per ton. Foundry scrap is quiet, but there has been no definite alteration in the position.

South-East Lancashire Electricity District.

A local inquiry is to be held in the Manchester Town Hall on Tuesday, January 17th, and following days by the Electricity Commissioners with reference to the area to be included in the above district. At this inquiry objections and representations that have been made on account of the exclusion or inclusion of certain areas will be heard, and a scheme which has been submitted to the South-East Lancashire Electricity Committee for the improvement of the organisation and for the establishment of a joint board will be considered.

New Electric Power Station for Salford.

The proposal of the Electricity Committee of the Salford Corporation to erect a new power station at Agecroft was approved last week. The estimated capital expenditure is £847,000. By means of this station it is proposed to increase the supply of energy to 45 million units per annum. As demonstrating how the cost of building construction has fallen during the last twelve months it may be mentioned that the first estimate of the cost of the station was £1,189,000. The Electricity Commissioners have approved the scheme. An excellent site at Agecroft, in close proximity to the river Irwell and in a colliery district, has been prepared for the station.

Science and the Textile Trade.

In the course of an address which he gave in Manchester a few days ago, Mr. Kenneth Lee, said that at the present time there were two big movements in the textile trade, on the material side the development of co-operative research by the British Cotton Industry Research Association, and on the human side the work of the Industrial Fatigue Research Board, both being capable of bringing about revolutions in this industry. The Cotton Research Association had now more than 1400 members, including more than 90 per cent. of all the spinners, manufacturers, dyers, bleachers and finishers in the country. There had not been any discovery of prime importance in the cotton trade for a large number of years. What progress had been made was in the perfecting of machinery which had the tendency to bring the industry on to more or less of a dead level. In the future development of the industry, Mr. Lee said, we must allow science to find out for us more of the life history and properties of the cotton fibre, and then users would be better able to co-operate with their scientific staff in making suggestions to machinists. Our future success in competing with other nations would depend largely on our being able to produce new and better fabrics and yarns. Mr. Lee mentioned the great strides which Swiss textile manufacturers were making in the world's markets, and especially in America, where the Swiss last year sent nearly one-half as much as the British, whereas in 1913 the Swiss proportion was only about one-thirtieth. There is, however, another and a more serious phase of the cotton industry to be shortly encountered. Mr. Fred Tomlinson alluded to it at a meeting of the Empire Cotton Growing Corporation. This is the prospective world's shortage of raw cotton. The normal crop of American cotton is about 16,000,000 bales, while this season it does not exceed 8,000,000 bales. In Egypt a somewhat similar state of affairs prevails. As the American consumption increases each year—and in the year 1917–18 it actually amounted to 7,000,000 bales—the outlook for British manufacturers is very black. The acuteness of the position points to the urgency of growing cotton in our own colonies.

BARROW-IN-FURNESS, Thursday.

Hematites.

The general condition of the hematite pig iron trade of North Lancashire and Cumberland is one of extreme quietness. The amount of new business being offered is exceedingly small. On Christmas Eve the Barrow Steel Company will damp down its furnaces until January 9th, when operations will be resumed. At present a good proportion of the Barrow output is going into direct use at the company's steel works. On Tuesday, a further cut was made in the price of West Coast hematite to the extent of 10s. per ton, and thus the margin is being reduced. The expectations are that there will be no marked improvement in trade until well into the spring, and there is the feeling that the worst has been passed.

Iron Ore.

At the mines there is not much activity, for the demand, mostly local, is very easy. Foreign ores are being imported, and prices much lower than native sorts.

Steel.

In the steel trade there is a fair amount of activity at Barrow and at Workington, but the demand all round is very quiet, and a lower range of prices is being sought. Rails continue to occupy most of the attention. Hoops are being rolled, foreign billets being used on account of the lesser cost. The foundries are fairly busy.

Shipbuilding and Engineering.

These trades are badly in want of new work. During the year Vickers Limited launched from the naval construction works at Barrow 64,320 tons of shipping and constructed 46,350 horse-power of machinery. The craft launched included liners for the Australian Government (two) and one for the Cunard Company, three oil-carriers for Tankers, Limited, and a cross-Channel steamer for the London and North-Western Railway. Machinery was also made for the London County Council and the Compania Transatlantica.

SHEFFIELD.

(From our own Correspondent.)

No Revival in Sight Yet.

ONE has no desire to withhold the least degree of sympathy from the Press campaign which blazes up every now and again in a commendable attempt to prove that industrially the country is meeting the first waves of a revival; but after saying that, one is still left with the deep conviction that the wish must be father to the thought. Personally, I am an optimist by birth, and,

with many others, am hoping for better things after the turn of the year; but so far as this part of the country is concerned there seems precious little of a revival in sight. As I have mentioned before, the main-line systems serving the Sheffield district are very keen competitors nowadays for what carrying business requires to be done, and just recently railway agents have been busy canvassing manufacturers' opinions of the prospects for trade in the New Year. Now it happened that a friend of mind, who had temporarily succumbed to a rather bad attack of the "blues," was interviewed by one of them. What my friend told the railway man I do not propose to discuss here, but at the end of the conversation, realising that he had painted a particularly dark picture, he tried to make some kind of amends by hoping his interviewer would not think him too pessimistic. "Pessimistic, sir," he exclaimed. "Why you are the most hopeful man I have interviewed to-day—absolutely. You should hear what some of them say!" I know, of course, that many manufacturers get into the habit—a very questionable one—of talking the position down, whatever their real views of it may be, but after due allowance has been made for those little foibles, one is still left with very little ground to dance on, out of unalloyed bliss at the prospect of a trade revival. It will arrive ultimately, without doubt, whether in the spring, as some forecast, or in eighteen months' time, as the Sheffield steel manufacturer, Mr. Arthur Balfour, fancies; but if you ask at the present moment, "Where are the signs of its coming?" I can only reply, in the words of a London omnibus conductor who a week or so ago, whilst on a rather long westward run, told me in confidence several things about the country's trade position, "There ain't none."

Not all Dark.

Which, of course, proved that even a man in that position can fall into the sin of exaggeration. For example, Sheffield considers itself as badly hit by the prevailing slump as any industrial centre in the country. Yet it has its patches of blue. The Yorkshire Engine Company, whose works are in the Meadow Hall district of the city, has been having trial runs of what I believe to be one of the finest types of locomotives—and one of the biggest—ever built in this country. I intend to say no more about it in this letter, because I understand the subject is to be dealt with fully and technically by The Engineer, but I hear the contract was on Spanish account, and in that case it follows, at no great distance, that similar business will be placed by French railway interests in the same quarter. There is little need for pessimism about that, though the margin of profit may have had to be cut fairly fine in these days. Another rather encouraging item I was told over the lunch table only this week. The representative of the Federation of British Industries at Buenos Aires, finding a German firm was selling a very serviceable-looking spanner at a c.i.f. rate that worked out at 2s. 7d. each to the Argentine buyer, sent one of the spanners home, and it found its way into the hands of the Sheffield representative of the Federation of British Industries. Following inquiries he instituted, he succeeded in interesting a tool-making firm here sufficiently to go into the matter, with the result that at once it was found, in spite of every handicap, that a Sheffield spanner, identical in quality and appearance, could be offered to the Buenos Aires market on c.i.f. terms bringing the price per spanner to a level half-a-crown. Now whilst Sheffield can do that, not even an omnibus conductor is justified in saying there are no prospects.

Files and the List Price.

On the other hand, I have had a call this week from an old friend who is, to use his own words, "unfortunately a file manufacturer." He tells me that business is at a complete standstill, or almost so. There is a little trickling through, but as a rule it seems a most unprofitable proposition. Forty-five per cent. off the list, he said, barely allows us to turn a sixpence, whereas many firms are offering files at 47½ off, while some, in order to secure sufficient business to keep their works even partially going, offer as much as 50 and even 55 per cent. off the list, which means, my friend tells me, a sheer 10 per cent. loss. Obviously, however, one must make some allowance for works run on lower overhead charges than others. But what appeared to trouble him more than anything else was the havoc which the release of enormous quantities of Government surplus stores at rubbish prices is working on the market. He himself had been offered good files 85 per cent. off the list by a man who had bought them from the Government at an auction price which worked out at over 90 per cent. off the list—all but given away. America, he assured me, is sending files to the British market at a rate which equals nearly 50 per cent. off, negotiations being carried through on the basis of a normal rate of exchange. "Put these things together," he added, "plus severe German competition, and a wonderfully wide and free field the English maker has in which to scrape together a portion, at least, of the money the Chancellor says is owing in the form of one kind of taxation or another."

Speaking of Taxation.

Speaking of taxation—that most unpalatable of words—Sir Robert Horne's Newcastle pronouncement on the subject of E.P.D. arrears has given a large measure of comfort to many manufacturers here, especially among the smaller ones, though, of course, like the Sword of Damocles, the Treasury demands will be suspended over their commercial heads by the single hair of a 5 per cent. rate of interest on all arrears outstanding. For this measure of relief traders have principally to thank the efforts of the Federation of British Industries and the Chambers of Commerce, but for what they are really gasping is an atmosphere a little less charged with the trade-destroying fumes of over-burdening taxation. For that apparently they will have to go on gasping for the present.

At Last.

After pounding away on the door of the G.P.O. until it seemed beyond question that their efforts were futile, Sheffield manufacturers have at last reasonable ground for believing that the Government will seriously take up the work of installing an automatic telephone exchange in the city. The steel men who, as the largest users, have been the greatest victims of the existing very inadequate and temper-spoiling arrangements, learnt on Monday, through the Secretary of the Chamber of Commerce, that the Postmaster-General understands from the Office of Works that the latter is about to invite tenders forthwith for the building of a new telephone exchange at Sheffield, and that contracts will be placed as soon as the tenders have been received and considered.

Rumanian Railways' Talk.

The question of the huge Rumanian railway contracts, about which a good deal was said a few months ago, appears to have been revived in London. It is said that a number of British engineering firms is very interested in the inquiry. So far as rolling stock renewals are concerned, the British firms most intimately interested have been hitherto Cravens, John Browns, and Thomas Firths, of Sheffield, and the Nasmyth locomotive building concern of Manchester. Browns control all the others named, but some time ago a sort of holding company was formed, embracing them all, and, I believe, known as Cravens, Limited, as distinct from Cravens Railway Carriage and Wagon Company, Limited. The Rumanian business was being negotiated as to one-half by the holding company named representing the British group, and as to the other half by a French group of railway engineers. The difficulty all along has been one of finance, and if now the matter is possible of adjustment by means of the Export Credits Department and some operation of barter, the proportion of the contracts which might be expected to come this way would make up in some measure Sheffield's loss of the naval contracts—if they really are lost—though I believe the actual reconstruction work is to be carried out in Rumania.

Reducing the War Bonuses.

In spite of the fact that the President of the Shipbuilding and Engineering Trades' Federation has been trying to stir the mud up over the question of wages and hours, the latter appears to be shaking itself down to reasonable proportions. On Sunday, for instance—which is a good enough day for any good deed—members of the Sheffield Iron and Steel Trades' Confederation decided to accept a reduction of 10s. per week in existing war bonuses, the new price to come into operation on January 1st and a few days earlier, at a conference here between the Federated Steel Makers and representatives of seven of the men's unions, the latter agreed to accept a reduction of the consolidated war bonus of 10s. a week, or 1s. 8d. a shift, to come into operation at the same time.

Which?

The launch of the latest recruit to the list of local trade technical societies, in the Mappin Hall of the University, was a very notable success, and if the enthusiasm displayed by the 200 or so "first nighters" of the Rolling, Forging and Tilting Trades' Technical Society is only maintained and communicates itself to the members of the four kindred bodies, the second half of the session should prove an exceedingly profitable one. Professor Ripper presided, and Mr. C. E. Siddell, in the course of a particularly sound address, drew attention to the peril being brought about by a serious fall in the number of skilled men available. For the youth of to-day the question was, "Muck and money; or starch and starvation—Which?"

NORTH OF ENGLAND.

(From our own Correspondent.)

A Better Trade Outlook.

There are welcome indications—slight as yet, but nevertheless definite—that trade generally is, at long last, on the upward grade, and the outlook is distinctly better. There is evidence everywhere that industry generally is adapting itself to the competitive demands of the times, and in the iron and steel trades prices are now almost on a level with those on the Continent. A big share of the business now coming out should, therefore, find its way to British manufacturers. The announcement made at Newcastle by Sir Robert Horne that firms which are in arrear with that much-disliked thing the excess profits duty, may make remittances on an easy payment system spread over five years has come at a very opportune time. It is a concession that will give industries a little impetus which is so badly required. It is encouraging to record that Swan, Hunter and Wigham Richardson, Limited, of Wallsend, have booked an order for two steamers for the Canadian lakes trade, in the construction of which class of vessel the mid-Tyne firm has had considerable experience. This is the first order received by a Tyneside shipbuilding firm for a long time, and it is especially fitting that the work should have come to a yard which, through the decision of the Admiralty, influenced by the Washington Conference, received instructions to suspend work upon the battleship of the super-Hood class that would have otherwise been built there. Another encouraging piece of news this week is that Dorman, Long and Co., Middlesbrough, as the result of their union with Messrs. Braithwate and Co., engineers, of West Bromwich, and Newport (Mon.), have obtained a valuable contract for supplying and laying some 60 miles of double pipe line for the Bombay Corporation. This means the supply of 70,000 tons of plates during the next three or four years—a weekly quantity of about 500 tons when the firm start on the order about six months hence.

Cleveland Iron Trade.

Quietness still characterises the Cleveland pig iron trade, but there is a growing feeling of optimism, and the opinion is expressed that after the Christmas and New Year holidays a general improvement may be experienced. There has been a better inquiry for Cleveland pig iron, but the output still seems to be sufficient for present demands. Improvement in the coastwise shipments, both to Scotland and to Wales, is a healthy feature.

Hematite Pig Iron.

The closing of the Scottish blast-furnaces producing hematite cannot be regarded as a favourable sign, but it should have some appreciable effect upon the demand for East Coast hematite, and with four additional hematite furnaces in blast locally, there is certainly need for more markets for local iron. There is no fixed price for East Coast hematite, and under the influence of the keen competition, prices are still dropping. In some cases 105s. per ton is asked for mixed numbers, but 102s. 6d. is now an average quotation, both for home consumption and for export, with No. 1 at a premium of 2s. 6d. per ton. At this figure East Coast hematite is much the cheapest in the country, and local makers are getting the bulk of the orders.

Iron-making Materials.

The long-continued stagnation in the foreign ore trade is having its effect on prices. Whilst a seller's nominal price is still 27s. per ton, business below that figure would not be turned away. There is, however, no demand, and with holidays at hand buyers will not do business at any price. The price of blast-furnace coke delivered at the works is now no more than 29s. per ton, and that figure could no doubt be shaded.

Manufactured Iron and Steel.

There is little change in the manufactured iron and steel trade. The production in this district has fallen to its lowest ebb for several months, and there is little business coming forward. But there is a firmly-founded belief that with the turn of the year demand will improve, though it is admitted that prices will have to fall further yet and makers are very anxious to hasten the fall. On the other hand, they have reached almost the limit of sacrifice, and feel that any reductions must come as the outcome of cheaper fuel and railway rates.

The Coal Trade.

The Northern coal situation is gradually undergoing a change from the rather strong position of the last few weeks, and the market generally is easing away in most directions. There is still, on the whole, a satisfactory demand, but the temporary rush is about over, and with numbers of collieries re-starting work and others working more regularly, coupled with an increasing output per day, there are now abundant supplies on offer for almost any period of shipment or delivery. The attention of both collieries and exporters, for the time being, seems to be entirely absorbed in business to the end of the year, and for this there is no apparent change in value. The steam coal collieries, being well booked to the end of the year, stand rigidly to the spot quotations with 25s. as a basis for best steams, and all other classes at proportionate figures. As regards forward business, there is very little under discussion. Exporters apparently anticipate that by the middle of January current figures will have been considerably deflated, and many will be induced to place forward business on those lines. On the other hand, collieries, regarding the situation as uncertain, are not willing to discount their prices to anything like the amount which would be necessary to meet merchants' ideas, so that for the time being forward business is in abeyance. The Durham market seems to manifest a steadier tone, and coalowners are able to obtain current figures. Whether this is temporary or will continue to the end of the month remains to be seen, but as regards best brands of gas, coking, and bunkers, figures are firm, while in secondary classes, though plentiful, there is not the disposition to break the prices that was evident a week ago. Household coal provides a steady market, but having regard to the season of the year, there is not the buoyancy and activity that should be in evidence. This state is partly due to the hope that prices have not reached their lowest limit, and may be further reduced; and also to the depression in trade generally, which is soon reflected in this branch of the trade. Coke continues to be almost dead as regards all classes of furnace and foundries, though gas coke is a steady market at top prices for prompt. The forward position is uncertain, and nothing is being booked ahead.

SCOTLAND.

(From our own Correspondent.)

Looking Ahead.

Though existing industrial conditions give little apparent cause for satisfaction, there appears proof that manufacturers and merchants anticipate better things at no distant date. At any rate, producers meantime continue to accept what business offers in order to keep things going, even although in many cases a loss is entailed. Producers further recognise that in order to re-establish a footing in overseas markets considerable loss has to be sustained. Prices of most commodities have fallen about 50 per cent., and in many cases a considerable degree below a figure justified by oncost charges. Inquiries for material have been more prevalent of late, and local makers are determined to maintain a foothold in view of better things to come.

Rail Charges.

Now that wages and other costs have come under revision, and in some cases reached the lowest possible limit meantime, the existing rail charges are receiving great attention, and on all sides blamed for keeping prices much higher than need be. It has been said that railwaymen's wages should be reduced, as has been done in industrial trades, and though perhaps a slight reduction might be made, the standard in Scotland does not appear to the ordinary observer to be excessive, even though in

some cases it is 200 per cent. above pre-war levels. On the other hand, the railways must be saving money now on coal, oil and materials for rolling stock, permanent ways, &c., sufficient to warrant substantial decreases in charges for transport. Wages are already 9s. lower, which alone will mean a considerable saving. With the advance in railway rates in September last year, an average increase of 113 per cent. above pre-war charges was reached. In 1913 the returns showed that out of 100, revenue accounted for 37 and costs 63, and it is said that to-day the revenue remains the same. Therefore, subtracting 37 from 213 shows an increase in costs from 63 to 176. When the savings already referred to are taken into account, a considerable reduction might surely be made in the last figure.

Pig Iron Position.

The position of the pig iron trade is distressing. Prices are almost on competitive lines, but business is not forthcoming, and the production is not being got rid of. Only eighteen furnaces—one of which is making hematite—are in operation, and some may be damped down. The situation in the local steel and iron trades makes home business of little account, and unfortunately export is no better.

Steel and Iron.

While, generally speaking, makers are now in a better position to cope with outside competition, in view of the continued reduction in prices, conditions remain almost unchanged otherwise. Only very small transactions are mentioned, and consumers will not consider replenishing of stock, while there is no fixity in costs. At present the steel works have a larger inquiry, but orders placed are not sufficient to go round, and many mills are idle and the rest only partially employed. Competition from England is more pronounced. Structural material is busier, both on home and foreign account. Black and galvanised sheets are also busier. Contracts held up during wartime and since then by excessive prices are now coming into the market. Steel and iron tubes are booking a fair amount of orders on export account, but home business is light. Bar iron is very slack, and it is questionable if the latest reduction in prices have been of any benefit. Many consumers are themselves in a poor position and cannot afford to buy lavishly, even at current prices.

Coal.

The Scotch coal trade has not altered much. Land sale is still restricted to a marked degree, and any improvement is in the export department. Gas and electricity works take regular supplies, and railways pretty full deliveries, but otherwise things at home are very dull. Dross and small nuts are in poor demand for local consumption. On the other hand, collieries in the West of Scotland have good orders for ells, splints, treble and double nuts for shipment. First-class Fifeshire steams are comparatively well booked, and trebles and double nuts are doing well. In the same district single nuts are doing a fair turnover for the London market. In the Lothians, also, treble and double nuts have fair shipping orders. Steamers are again in better supply and freights tend easier. Aggregate shipments amounted to 208,015 tons, against 190,469 tons in the preceding week and 337,368 tons in the same week in 1913.

Cheaper Coal.

It seems to be widely recognised that coal will soon be considerably cheaper. Already much lower rates are current. Coal which in October was 28s. 6d. per ton is now 24s. f.o.b., and it is said that for export delivery next year concerning orders of good dimensions 7s. less than the latter figure has been quoted.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Improving Coal Trade.

INDICATIONS of more active conditions in the coal trade have become more pronounced during the past week, and there is a distinctly better tone prevalent on the market. Of course, the increased pressure which is being experienced on account of the Christmas holidays, and is reminiscent to some extent of pre-war days, is responsible for the firmness in values, which have improved on the prices of a week ago. The recovery in prices may not be much, and cannot be altogether described as general in its application, but this much can be said, that this is the first time this year that values have pursued any other course than that of downward. To compare the conditions with those existing before the war, in respect of the pressure now being witnessed is scarcely reasonable; as they are far from being on all fours. At the present time numerous collieries are idle for the reason that current prices in relation to their output are unremunerative, but the fact that so many pits are at a standstill has meant a bigger call on the collieries which are engaged, and the latter are reaping the benefit of the inquiry for prompt supplies in order that cargoes may be got away before the holidays. At the same time, while many no doubt consider that the improvement in the market is only of a temporary character, and that values will relax immediately that idle collieries resume operations and swell the output, the fact remains that many undertakings are full up with orders for this month and have some bookings for next, and are not disposed to discount prices for January. One thing noticeable is that business over the first six months and even over the whole of 1922 is being discussed more freely, and some important contracts have been arranged. Those colliery owners who tendered for the requirements of the British Admiralty over next year have received during the past week acceptances. Exactly what quantity was actually placed is not known, as that is information which is never disclosed, but it is reported that the total runs to about half a million tons, which compares with a million and a-quarter or more in pre-war times. The prices paid compare very favourably with current values, and are not subject to a rebate in the event of railway charges being reduced.

Foreign Inquiries.

The Bombay and Baroda Railway Company, which a month or so ago purchased about 150,000 tons of Welsh steam coals, has asked for tenders for a further 60,000 tons of Admiralty and Monmouthshire large descriptions for shipment between January and May next, tenders to be on a c.i.f. basis and for discharge at Bombay. Much prominence has been given to reports of a further big inquiry on behalf of the Indian Government, and it has been freely stated that the quantity is 250,000 tons of Cardiff and Monmouthshire large qualities for shipment over twelve months as from January next, and that tenders have actually been sent in. There, however, seems something strange about the whole business, as nothing can be gleaned in official quarters regarding any inquiry having been sent out. The reports created quite a deal of interest, both in coal and shipping circles, more particularly the latter, seeing the amount of employment that would be afforded to tonnage.

Shipping Facilities.

The loading pressure now being experienced at the docks is bringing forth a fruitful crop of complaints regarding delays to tonnage, and, of course, in these days when freight rates are unremunerative and the essence of running ships successfully is quick dispatch, the matter is of more than ordinary importance. It is reported that as many as thirty ships have been held up in dock unable to get into berth, and that congestion has been rife more at Barry than at any other port. These complaints have naturally caused some alarm regarding the future, and the prospects of dealing with increased trade. Already it is stated that many orders have been lost, more especially bunkering orders, and that owners have refused to send their ships to this Channel unless they can get an assurance that they will be bunkered in a reasonable time and not be held up three or four days waiting for a berth. It is to be feared that some of the dock companies are not overanxious to have large steamers coming to their docks to take in bunkers only, as the docks are not built and equipped to deal with them adequately, as such vessels take up so much space and prevent adjoining tips being employed. Coalowners and shipowners are contending that the only way to relieve the pressure is for the working hours and conditions at the docks to be revised, and for the three-shift system to be re-adopted as in pre-war days, but the reply of the workmen's leaders and of some of the companies is that tonnage is not as equally distributed among the docks as it might be, and that consequently all workmen are not even now engaged full time; but it is pointed out that the railway and dock companies do not want to face the expenditure necessary for the third or night shift, as it means the employment of more men at the docks and on the railways.

Dock Workers' Dispute.

As was expected, the strike of dock pilots, boatmen and riggers at South Wales ports has not lasted long, and as shipowners demonstrated that they were very well able to get along without the aid of their services, the men soon made overtures for a settlement, and there were conferences on Friday and Saturday, which resulted in an official settlement, although at the time of writing all the men are not back at work. Their return is not likely to be long delayed, however. The actual terms of settlement have not been disclosed, but from what can be gathered, the Shipping Federation tariff stands, so far as the dock pilots are concerned, and some slight concessions have been made in the case of the boatmen and riggers. At the moment some of the men are still idle at Cardiff, although they have resumed at the other ports. The position is that the tug-boat owners who dispensed with the services of their crews, are taking advantage of the situation to have a settlement with their men on the wages question, and seeing that the crews of these tug boats in the first place gave support to the dock pilots, boatmen and riggers, the latter have declined to restart work until the crews of the tug boats settle their little dispute satisfactorily. Shipowners are not, however, upset, and are simply waiting, knowing full well that the men will go back when they get tired of seeing that they can be done without.

Wages Questions.

The coalfield conference recently referred to the lodges for decision of the question whether the coalowners' offer concerning the subsistence allowance and the conditions thereto should be accepted, rejected or referred to the Independent Chairman for his award. The replies of the lodges show that while many are in favour of referring the matter to the Independent Chairman, there is a majority for rejection of the coalowners' offer. The Bristol Channel Dry Dock and Ship Repairers' Federation, Limited, has made application for an all-round reduction of 12s. 6d. per week in the wages of skilled, semi-skilled and unskilled workmen, and it is proposed to wipe out the Ministry of Munitions bonus of 7½ per cent. on total earnings granted to piece workers, together with the increases on the price lists given for abnormal work during the war. Proposals have been made by employers for a further reduction of 30 per cent. in the tariff of coal trimmers, but the men concerned are doing their utmost to resist them.

Current Business.

During the past week the inquiry for steam coals has certainly been more active, but buyers of supplies for shipment this side of the holidays are experiencing no little amount of difficulty in getting their requirements owing to the stems of loading colliery companies being very full for the whole of this month. Best Admiralty large coals are now quoted at 26s. to 26s. 6d. Patent fuel in the case of the tip-top brands is firmly quoted at 28s. 6d. to 29s. 6d. The tone all round is better.

Latest News from the Provinces.

WALES AND ADJOINING COUNTIES.

Miners' Subsistence Allowance.

THE Executive Council of the South Wales Miners' Federation has decided in view of the voting of the lodges on the coalowners' offer respecting the payment of the lower-paid workmen, to have a memorandum prepared showing the position of the industry and the wages of the workmen, with a view to making a demand that wages shall be paid in accordance with the cost of living.

Dockworkers' Dispute.

Terms having been arranged between the tug-boat owners and their crews, a resumption of work was expected to be made on Thursday, 15th inst. The dock pilots, boatmen and riggers at Cardiff who refrained from work in sympathy with them are also likely to be back at work at the same time.

Cardiff's Import Trade.

Arrangements have been made by one of the largest firms of importers of frozen meat in this country for cargoes to be brought direct from Australia to Cardiff. One steamer is now about to sail for Cardiff and another is due to leave Australia with supplies about the end of December, while other boats are to follow. Hitherto, supplies have been brought to this country and then taken by rail to Cardiff, where the Cardiff Railway Company has storage facilities.

INSTITUTION OF ELECTRICAL ENGINEERS.

AT an informal meeting of the Institution of Electrical Engineers, held on December 5th, Mr. C. L. Lipman presented a paper on "Some Developments in the Design of Alternating-current Instruments." The meeting was rather less crowded than on previous occasions, and the discussion was not a lengthy one. Mr. Lipman exhibited diagrams and lantern slides showing the details of these instruments. Actual examples of instruments made by Nalder Bros. and Thompson were also shown. The power factor motors, frequency motors and synchroscopes which Mr. Lipman described have an improved movement which is devoid of coils and is designed with a view to securing extreme lightness, perfect balance and accuracy and a very small energy consumption. A sensitive relay, intended mainly for use with Merz, Price and Sinclair protective systems, was also exhibited. The principle is similar to that of a moving iron ammeter. The device is claimed to be unaffected by vibration, to work with very low power (*i.e.*, .01 volt-ampère), to be self-setting, and to give a positive indication of having operated. The relay contact is always held in until the circuit is cleared, and there is consequently no sparking. Contributions to the discussion were made by Major K. Edgcombe, F. H. Nalder, H. Brazil, and Mr. A. G. Kemsley.

UNEMPLOYMENT RELIEF IN ITALY.

ACCORDING to the *Corriere d'Italia*, of the 268,000,000 lire provided by the Italian Government to alleviate unemployment by the construction of public works, the greater part will be apportioned as follows:—61,000,000 lire for bridges and roads, of which 24,000,000 will be devoted to the construction and repair of municipal carriage roads and mule paths, the provinces of Basilicata, Calabria and Sardinia, for which special arrangements have already been made, being excluded; 45,000,000 lire for hydraulic works, of which 800,000 are for the harbour near Pavia, 4,000,000 for improving the navigability of the Po, 6,000,000 to be spent on the embankments of the Tiber, 5,000,000 on those of the Arno, and 5,000,000 for similar work in South Italy and the islands; 50,000,000 lire for harbour works, of which 3,100,000 at Ancona, 1,500,000 at Brindisi, 1,000,000 at Catania, 3,500,000 at Leghorn, 1,000,000 at Piombino, 1,000,000 at San Benedetto del Tronto, 4,000,000 at Savona, 700,000 at Torre Annunziata, 1,000,000 at Pescara-Castellamare Adriatico, 1,500,000 at Castellamare di Stabia, 600,000 at Fanno, 1,000,000 at Gaeta-Elena, 1,500,000 at Formica, 600,000 at Nolfetta, 800,000 at Ortona, 1,000,000 at Pesaro, 1,000,000 at Riposto, 500,000 at Scario, 1,000,000 at Salerno, 1,100,000 at Sciacca, 1,250,000 at Stracuse, 1,500,000 at Taranto, 300,000 at Termoli, 2,000,000 at Terranova di Sicilia, 2,000,000 at Viareggio, and 500,000 at S. Vito Chietine. In addition, 3,000,000 lire are allotted to lighthouses and buoys, 5,200,000 for dredging, and 5,700,000 for coast protection works; 6,500,000 lire are to be devoted to building Government offices at Potenza, 42,000,000 are apportioned to the south of Italy, of which 13,000,000 will be spent on the subjugation of mountain torrents and streams, 15,000,000 on drainage, and 14,000 on sea coast works in Calabria; 2,000,000 lire are set aside for raising the lower part of the town of Pozzuoli, 4,000,000 for repairs and construction of State roads damaged or destroyed by the war; 1,000,000 for maintenance and completion of roads in the war zone, and 33,000,000 for hydraulic works in the provinces of Venice and Mantua.

CONTRACTS.—We understand that Meldrums, Limited, Timperley, near Manchester, have just completed ninety sets of their "Sack" disinfector for the Spanish Government, and that a number of this firm's forced draught furnaces has been installed by industrial firms during the last two months.—Ed. Bennis and Co., Limited, have recently received orders for:—Fourteen sets of sprinkler stokers and compressed air furnaces; three sets of "coking" stokers and compressed air furnaces; five chain grate stokers; seven elevators of various types; and one coke breeze disposal plant.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	37/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. COAST—	
Native	—
Foreign (c.i.f.	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	6 0 0	—
No. 1 Foundry	6 5 0	—
No. 3 ,,	6 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	5 2 6	5 2 6
No. 1	5 5 0	5 5 0
Cleveland—		
No. 1	5 5 0	5 10 0
Silicious Iron	—	—
No. 3 G.M.B.	5 0 0	5 5 0
No. 4 Foundry	4 15 0	4 15 0
No. 4 Forge	4 10 0	4 10 0
Mottled	4 5 0	4 5 0
White	4 5 0	4 5 0
MIDLANDS.		
Staffs.—		
All-mine (Cold Blast)	15 0 0	—
Part Mine Forge	*None offering.*	
,, Foundry No. 3	*None offering.*	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 15 0	—
,, Forge	4 4 0	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0 to 4 17 6	
Forge	4 10 0	—
Lincolnshire—		
Basic	*Uncertain.*	
Foundry	,,	—
Forge	,,	—
(4) N.W. COAST—		
N. Lancs. and Cumb.		
Hematite Mixed Nos.	6 5 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best ,,	17 0 0	—
N.E. COAST—		
Common Bars	12 10 0	—
Marked ,,	18 0 0	—
Tees	14 10 0	—
LANCS.—		
Crown Bars	13 0 0	—
Hoops	16 5 0	16 0 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	14 0 0	—
Hoops	15 5 0	—
MIDLANDS—		
Marked Bars (Staffs.)	16 0 0	—
Crown Bars	12 15 0 to 13 0 0	
Nut and Bolt Bars	12 10 0 to 13 0 0	
Gas Tube Strip	13 10 0	—
Hoops	16 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	14 0 0	—
Ship Plates ¾in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ¾in.	12 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 15 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 10 0	—
Heavy Rails	10 10 0	—
Fish-plates	15 10 0	—
Channels	14 10 0	—
Hard Billets	9 10 0	—
Soft Billets	7 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	11 0 0	—
Light ,,	13 0 0 to 15 0 0	
Billets	9 10 0	—
Ship Plates	10 10 0	—
Boiler ,,	16 0 0	—
MANCHESTER (*Prices irregular and uncertain, unchanged*)—		
(8) Bars (Round)	10 0 0 to 12 0 0	
(8) ,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
SHEFFIELD—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	10 0 0	—
Soft ,,	8 10 0 to 10 0 0	
Hoops	13 5 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	10 0 0 to 10 10 0	
Bessemer Billets	8 0 0 to 8 10 0	
(2) Hoops	12 0 0 to 12 10 0	
Gas Tube Strip	11 10 0	—
Sheets (24 W.G.)	15 0 0	—
Galv. Sheets (f.o.b. L'pool)	17 15 0 to 18 10 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/6 to 21/3
Block Tin (cash)	169 15 0
,, (three months)	171 10 0
Copper (cash)	66 12 6
,, (three months)	67 12 6
Spanish Lead (cash)	25 10 0
,, (three months)	24 15 0
Spelter (cash)	26 12 6
,, (three months)	26 18 9
MANCHESTER—	
(9) Copper, Best Selected Ingots	69 0 0
(9) ,, Electrolytic	74 0 0
(10) ,, Strong Sheets	101 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 4½
Lead, English	26 10 0
,, Foreign	25 10 0

(*Metal prices practically unchanged*).

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£28	12/-
,, 6 p.c. to 8 p.c. ,,	£26	10/-
,, 8 p.c. to 10 p.c. ,,	£26	10/-
,, Specially Refined		
Max. 2 p.c. carbon	£79	28/-
,, 1 p.c. ,,	£94	32/-
,, 0·75 p.c. carbon	£110	41/-
,, carbon free	2/8 per lb.	
Metallic Chromium	5/6 per lb.	
Ferro Manganese	(per ton) £18 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	21/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/6 per lb.	
Nickel (per ton)	£190	
Cobalt	14/6 per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	25/-
,, ,, Ell	25/6
,, ,, Splint	26/- to 30/-
,, ,, Trebles	25/6
,, ,, Doubles	23/-
,, ,, Singles	17/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	24/-
,, ,, Splint	26/6
,, ,, Trebles	25/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	20/- to 25/-
Screened Navigation	29/-
Trebles	25/6
Doubles	22/6
Singles	18/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	23/6
Secondary Steam	23/-
Trebles	25/6
Doubles	22/-
Singles	17/6

ENGLAND.

(11) N.W. COAST—	
Steams	34/-
Household	40/- to 55/-
Coke	34/- to 36/6
NORTHUMBERLAND—	
Best Steams	24/- to 25/-
Second Steams	21/6 to 22/-
Steam Smalls	15/-
Unscreened	21/6
Household	25/- to 30/-
DURHAM—	
Best Gas	23/- to 24/-
Second	20/- to 22/-
Household	25/- to 30/-
Foundry Coke	37/6 to 40/-

SHEFFIELD—	Inland.
S. Yorks. Best Steam Hards	25/- to 26/- —
Derbyshire Hards	24/- to 25/- —
Seconds	23/- to 24/- —
Cobbles	23/- to 24/- —
Nuts	22/- to 23/- —
Washed Smalls	17/- to 18/- —
Best Hard Slacks	17/6 to 18/6 —
Seconds ,,	17/- to 17/6 —
Soft Nutty ,,	17/- to 17/6 —
Pea ,,	11/6 to 12 6 —
Small ,,	9/- to 10/- —
House, Branch	39/- to 41/- —
,, Best Silkstone	37/6 to 39/- —
Blast Furnace Coke (Inland and Export)	22/6 to 27/6

(12) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	25/6 to 26/6
Second ,, ,,	25/- to 25/6
Best Dry Large	25/6 to 26/6
Ordinary Dry Large	24/6 to 25/-
Best Black Vein Large	23/6 to 24/6
Western Valley ,,	23/- to 23/6
Best Eastern Valley Large	23/- to 23/6
Ordinary ,, ,,	21/6 to 22/6
Best Steam Smalls	18/- to 19/-
Ordinary ,,	12/6 to 17/6
Washed Nuts	35/- to 40/-
No. 3 Rhondda Large	29/- to 30/-
,, ,, Smalls	20/- to 21/-
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	15/- to 17/-
Coke (export)	37/6 to 42/6
Patent Fuel	26/- to 29/-
Pitwood (ex ship)	32/6 to 35/-
SWANSEA—	
Anthracite Coals:	
Best Large	57/6 to 60/-
Seconds	52/6 to 55/-
Red Vein	47/6 to 50/-
Big Vein	55/- to 57/6
Machine-made Cobbles	72/6 to 75/-
Nuts	72/6 to 75/-
Beans	57/6 to 60/-
Peas	20/- to 22/-
Breaker Duff	8/- to 8/6
Rubbly Culm	11/- to 11/6
Steam Coals:	
Large	25/- to 27/6
Seconds	24/- to 25/-
Smalls	12/6 to 16/-
Cargo Through	20/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Prices represent the real market before the *official* change was made. (9) These prices are practically alike now. (10) Sheets reduced while other prices are advancing.

(11) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (12) Per ton f.o.t.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Outlook.

IN some branches of the engineering trades there are evidences of a little more activity, but in a general way the situation is far from satisfactory, and it is with the greatest difficulty that many firms are able to keep their hands employed. Still there is no appreciable addition to the ranks of unemployed, which are comparatively small. One of the greatest difficulties at the moment is to procure sufficient supplies of cokes. The consignments from the Ruhr district are far less than had been stipulated for under the arrangement with Germany, and efforts are therefore being made to improve the quality of the Saar cokes, in which direction it is claimed that satisfactory progress has already been achieved. It is hoped in this way to start a larger number of furnaces, of which only fifty-one were in blast on October 1st, out of a total of 220 in France and Lorraine existing before the war. Amongst the engineering industries, shipbuilding is in a particularly precarious position at the moment. At many of the shipyards the men are employed upon repairing locomotives and wagons, building internal combustion engines and turning out constructive material. As the result of the sale of the French merchant fleet it is hardly likely that the shipyards will find much work for some years to come, except perhaps on oil tank steamers. The pushing forward of the naval programme, in which submarines figure largely, is intended principally to provide some employment to the shipbuilding industry.

Public Works.

So numerous and important are the undertakings to be put in hand that the Minister of Public Works was only able to give partial satisfaction to those who wanted to know, during the course of the debate on the Estimates, what was being done to carry out the vast programme. He admitted that owing to lack of funds he could do little beyond hastening forward the preliminary work. So far as the railways are concerned, much is being done to ensure the safety of passengers by unifying signalling systems, replacing gas by electricity for the lighting of trains, constructing coaches entirely of metal and installing the "crocodile" or contact system for repeating signals in the locomotive cabs, while an order has been given out for a thousand Augereau apparatus in which the signals are repeated by a wireless receptor. The whole policy of the Minister of Public Works during the past few years has been in the direction of standardising everything on all the lines and electrifying the railways wherever possible. Most attention is being given just now to the works necessary for relieving the congestion of the Gare St. Lazare, where there are 1500 arrivals and departures of trains every day. Apparently the plans for constructing a low-level station for the suburban traffic are not expected to provide a complete solution of the problem, for the Minister announces that proposals are being investigated for creating a terminus for the ever-growing suburban traffic elsewhere. Little consolation was given to those who are anxious to see the carrying out of the scheme for rendering the Loire navigable, while even the Rhone project is not making so much headway as expected, chiefly through the difficulty of procuring the necessary funds. There is also some trouble through the refusal of the Swiss authorities to permit the raising of Geneva Lake, which is necessary for the complete success of the Rhone scheme. It is still hoped that the only two cantons which object to the raising of the level will give their consent when it is proved that adequate precautions can be taken against inundations.

A 280,000 Kw. Station.

During the recent international conference of electrical engineers in Paris a visit was made to the new electrical generating station at Gennevilliers, which, when completed, will be, it is stated, the most powerful in the world. The Paris distribution has always presented serious difficulties on account of the diversity of currents employed, since the different installations were laid down at various periods when the industry had not settled upon the most suitable type of current for public supply. After the war a company was formed under the title of the Union Française d'Electricité to reorganise and unify the Paris distribution, and rather less than two years ago work was started upon the huge generating station at Gennevilliers, which will be practically completed by the end of the year and will replace the four existing stations at Alfortville, Asnières, Billancourt, and Puteaux, which produce altogether 152,000 kilowatts. In a bay 150 m. long, 23 m. wide, and 25 m. high five turbo-alternators are to be installed, each of 40,000 kilowatts. Each turbo-alternator constitutes a single machine with one turbine, instead of three, as is the case with machines of similar power elsewhere. The first turbo-alternator will be put in service on February 1st and the others in May, while it is intended subsequently to increase the capacity from 200,000 to 280,000 kilowatts. The current will be delivered under a potential of 60,000 volts over 125 kilom. of mains. Such a high voltage has been adopted in view of extending the distribution over very wide areas, and arrangements are already being made to supply current by overhead cables to towns like Creil, Mantes, Meaux, Corbeil, and Orleans. Another generating station is to be erected at Vitry, which will serve as a stand-by for the Gennevilliers installation, and while producing 80,000 kilowatts will receive 40,000 kilowatts under a very high potential from the Creuse. At the same time provision has been made at Gennevilliers for the putting down of transformers for the current which will in time be brought from the hydro-electric plants on the Rhone, the Rhine, and the Auvergne, so that Gennevilliers will become the distributing centre, not only for the Paris district, but also for the greater part of the North of France.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

170,991. August 26th, 1920.—WASHING OUT LOCOMOTIVE BOILERS, H. Broscombe, 17, Garton-terrace, East Park-parade, Leeds, and the Economical Boiler Washing Company, Limited, 14, New Burlington-street, London, W. 1.

IN this nozzle pipe for washing out boilers with warm water there are several jets, and they are arranged at an angle of about

Nº170,991

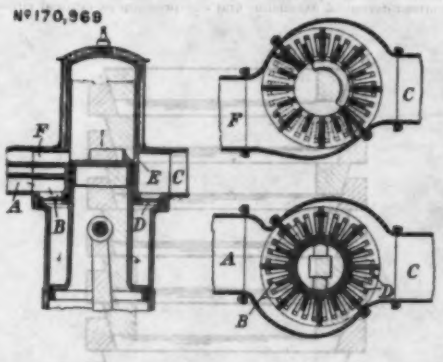
70 deg. to the axis of the pipe. The jets are fixed inside the pipe, as shown, in order to make the outside flush and thus permit the pipe being passed through a small plug hole.—*November 10th*, 1921.

INTERNAL COMBUSTION ENGINES.

170,969. August 9th, 1920.—TWO-STROKE ENGINES, W. K. Edgar, 1621, South 13th-street, Saint Joseph, Missouri.

In this two-stroke engine a trunk piston is used to pump the charge into the cylinder. The connection with the carburetter is marked A. The charge is drawn into the trunk

Nº170,969



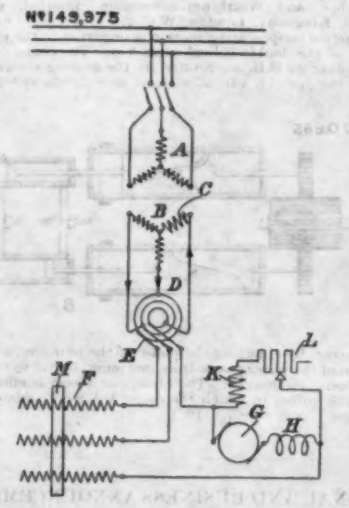
piston cylinder through the valves B and delivered into the reservoir C on the up stroke, through the valves D. The admission port of the working cylinder E and the exhaust F are normal.—*November 9th*, 1921.

DYNAMOS AND MOTORS.

149,975. July 30th, 1920.—DYNAMOS AND MOTORS: SYNCHRONOUS MOTOR FOR POLYPHASE CURRENT, Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland.

In the drawing, A indicates the stator winding of a three-phase motor. The rotor winding B is also arranged in star connection and one branch C has a larger cross section than either of the remaining branches through which the direct current leaves. The winding B leads to the three slip rings D which are connected through the brushes E to the starting resistance F. Between one of the brushes and one phase of the starting resistance the armature G and the compensating winding H of a direct-current dynamo are connected, the shunt magnet

Nº149,975

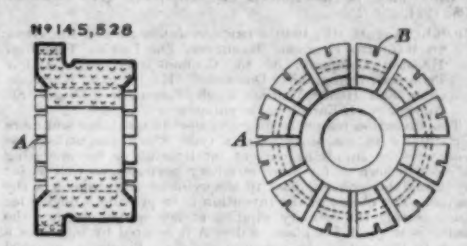


winding K of which is controlled by the regulating resistance L. On starting the motor the induced current for the rotor is established in the usual manner by the short-circuiting connection M of the starting resistance. The impedance of the circuit of one phase now differs from that of the other phase only by the uncompensated residual impedance of the armature of the direct-current generator. After synchronisation has been attained the starting resistance is short-circuited, at the same time the dynamo will generate direct current, which enters the rotor winding through one slip ring and leaves through the two remaining slip rings connected together by the short-circuiting of the starting resistance. The rotor is thus provided with a magnetic field produced by direct current, which keeps the motor in synchronism.—*October 31st*, 1921.

145,528. June 22nd, 1920.—IMPROVEMENTS RELATING TO THE CONSTRUCTION OF COMMUTATORS, Robert Bosch Aktiengesellschaft, of 4–8, Militarstrasse, Stuttgart, Germany.

The material used for the commutator bushing is either an insulating substance, such as Bakelite, or a ceramic substance, such as Stealite or porcelain. If Bakelite is used for the material it is turned in a lathe and the grooves A are afterwards made with a saw. The surfaces are then coated with graphite and the

Nº145,528



bushing is immersed in an electrolytic bath in which a coating of copper is deposited on the graphited surfaces. In order to prevent copper or graphite accumulating in the grooves, the latter are filled with cement. The shallow grooves B in the lugs of the segments are also made with a saw or cutter.—*October 24th*, 1921.

WIRELESS TELEGRAPHY.

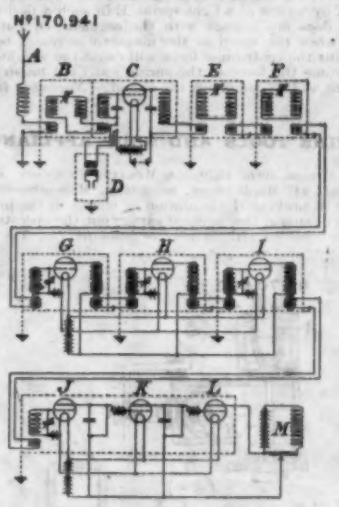
148,316. October 21st, 1914.—A DEVICE FOR CHECKING AND RECORDING AT THE SENDING STATION MESSAGES TRANSMITTED BY WIRELESS TELEGRAPHY, Dr. Erich F. Huth, G.m.b.H., Wilhelmstrasse 130/132, Berlin, S.W. 48, Germany.

This invention relates to an auxiliary apparatus for checking and recording messages sent out by wireless apparatus. At the sending station there is a separate Morse writer, which is independent of the receiving apparatus, and is actuated by local currents which are established when the Morse key is manipulated.—*November 9th*, 1921.

170,941. July 30th, 1920.—IMPROVEMENTS IN AND RELATING TO THE RECEPTION OF WIRELESS SIGNALS, Henry Joseph Round, of 9, Woodberry-crescent, Muswell Hill, London.

This invention relates to a method of using an apparatus for receiving wireless signals so that as little interference as possible may be experienced either from atmospherics or jamming waves. A is the receiving aerial, B an intermediate circuit by which the incoming signals are led to the grid circuit of a high frequency amplifier and rectifier C to which circuit oscillations are also led from a heterodyne D. The beat currents in the anode circuit of C are led to resonance circuits E and F built

Nº170,941



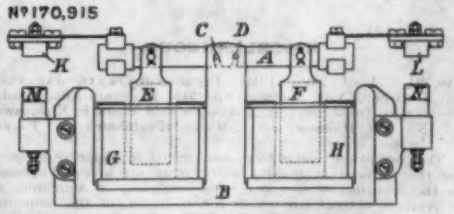
up of air condensers and a large amount of copper so as to give extremely low damping. The beat currents then pass through amplifying valves G H I to a rectifier J. The direct current is amplified by valves K L and actuates a recorder M. Earthed screening boxes indicated by dotted lines are provided for all the apparatus. If two different wave lengths are employed dots being given by one wave and dashes by the other, parts E to L are duplicated, the anode circuit of C being coupled to the two circuits, one of which is tuned to the one beat frequency and the other to the other frequency, and the currents from the duplicate valves L are led to a siphon recorder in opposite directions.—*October 31st*, 1921.

SWITCHGEAR.

170,915. July 27th, 1920.—IMPROVEMENTS IN BALANCED ELECTRICAL RELAYS, Adolph Harry Railing, Charles Cornfield Garrard and William Wilson, of 67, Queen Victoria-street, E.C. 4.

This invention relates to improvements in balanced electrical

Nº170,915

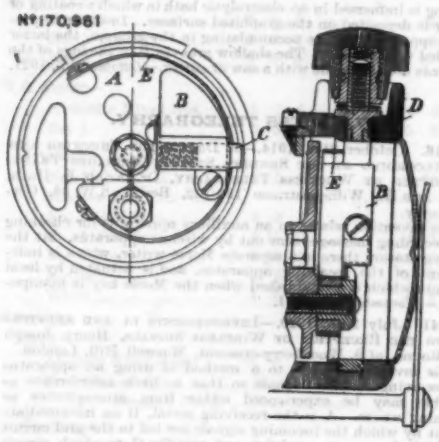


relays, and particularly to those used in connection with electrical protective systems. The relay is so arranged that it does not trip on one side or the other until the error in balance exceeds a definite percentage of the total current flowing in the system.

The beam A is supported on a frame B at the fulcra C and D. Suspended from the beam A at suitable distances from the fulcra are plungers E and F, which move in the solenoids G and H. The beam A is provided with contact pieces K and L at the ends and insulated from it. Corresponding fixed contacts M and N are mounted on the frame. When the left-hand plunger E is moved down by the attraction of the solenoid coil G the bottom or end of the right-hand groove rises from the seating pin D, the beam A turning about the fulcrum C. When the right-hand plunger F is moved downwards by the attraction of the solenoid H, the end of the beam A rises and turns about the fulcrum D. Since in either case only one fulcrum comes into play, its position may be determined by well-known rules.—*October 27th*, 1921.

170,961. August 4th, 1920.—IMPROVEMENTS IN AND RELATING TO MAGNETO ELECTRIC MACHINES, The British Thomson-Houston Company, of 83, Cannon-street, and Arthur Primrose Young, of "Dovedale," Kenilworth, Warwickshire, and Henry William Hugh Warren, of "Lynn," St. Andrew-road, Earlsdon, Coventry.

This invention relates to magneto electric machines and more particularly to machines of this type which are utilised as generators for supplying current for lighting or for operating an electric horn or for other auxiliary purposes, as well as for providing the ignition spark in the cylinder or cylinders of the engine. The object of the invention is to provide a device for disconnecting the primary winding at low speeds or when the engine is stopped. A plate or disc A is secured by means of a screw to the end of the magneto spindle. Pivotally mounted

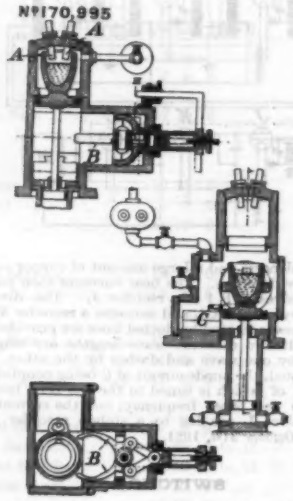


on this plate is a weighted lever B which carries a spring pressed brush C adapted to engage with a conducting segment D embedded in a ring of insulating material. The lever is normally held by means of a light spring E in such a position that the brush does not engage with the segment D, but during operation when the speed of the magneto increases beyond a certain point the centrifugal force will cause the weighted lever B to overcome the force of the spring until the brush engages the segment and so completes the circuit.—*November 4th*, 1921.

MACHINE TOOLS AND SHOP APPLIANCES.

170,995. August 30th, 1920.—A MELTING FURNACE, J. H. L. de Bats, 41, Maple-street, Stoneham, Massachusetts.

In order to prevent the oxidation of metals in the process of melting and casting, the inventor carries out the operations in a closed chamber filled with an inert, or reducing, gas. The crucible



is supported on an hydraulic ram which, at the top of its stroke, brings the metal under the heating influence of the electrodes A A. When the charge is melted the crucible is lowered, and tilted by means of the tongs B, so that its contents are poured into the mould C.—*November 10th*, 1921.

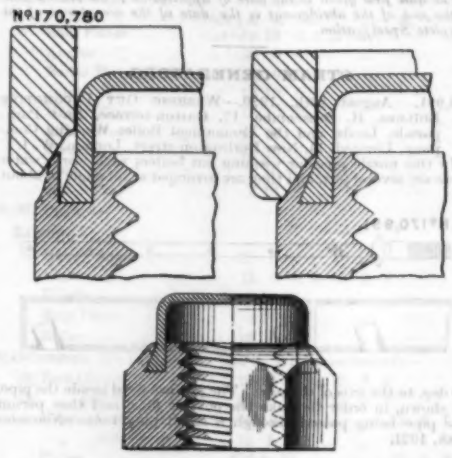
MISCELLANEOUS.

146,391. April 29th, 1919.—IMPROVEMENTS IN JAPANESE LACQUER, Yuji Shibata, No. 317, Hiyakunincho, Okubo Machi, Tovotama Gun, Tokyo Fu, and Yushichi Nishizawa, No. 110, Hakusan Goten Machi, Koishikawa Ku, Tokyo, Japan.

This invention relates to improvements in Japanese lacquer, for the purpose of making it dry more quickly, and consists in the addition of complex salts consisting of ammonia, or derivatives thereof (in which the hydrogen of the ammonia may be replaced by an organic radicle such as phenyl or the like) and salts of certain metals. In carrying the invention into effect, complex salts such as cupri ammine sulphate or zinc ammine sulphate, or complex salts which contain cobalt, nickel, manganese, calcium, magnesium, aluminium or tin, instead of copper or zinc, may be mixed with the lacquer. First, the proper quantity of these complex salts is mixed and well kneaded with a little drying oil. Next, a small quantity of Japanese lacquer is added to the mixture and is kneaded for about an hour until no crystal granule of salts can be felt. Then, it is again mixed with Japanese lacquer, and, if the proportion of the complex salts be from 20 to 30 per cent., the mixture will become plastic, and perfectly dry in an hour or two.—*November 2nd*, 1921.

170,780. December 9th, 1920.—CAP NUTS, D. B. Morison, Hartlepool Engine Works, Hartlepool.

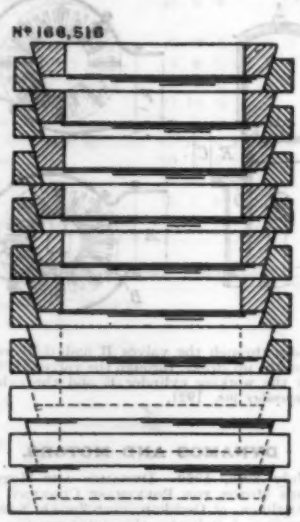
In order to cheapen the manufacture of cap nuts which have to be leak-proof under considerable pressure, the inventor



makes them in two parts. The nut proper has a groove cut in its face and after a dovetailed cap has been put in place the groove is closed in by a die as shown in the drawing.—*November 3rd*, 1921.

166,516. June 8th, 1921.—SPRINGS, E. Kreissig, 93, Moerserstrasse, Uerdingen, Germany.

The inventor proposes to provide a spring action by utilising the circumferential extension and compression of conical rings,

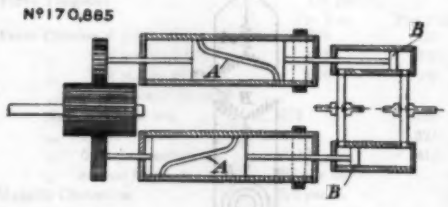


which are forced into one another by the load. He claims that the capacity of the spring is at least three times as great as that of the best torsional spring.—*November 3rd*, 1921.

PUMPING AND BLOWING MACHINERY.

170,885. May 26th, 1920.—RECIPROCATING PUMPS, W. R. M. Churcher, and Worthington-Simpson, Limited, Queen's House, Kingsway, London, W.C. 2.

In this pump reciprocating motion is imparted to the plungers by means of the double helical cams A A. The cams, together with the plungers B B, are rotated by the gearing shown. The output of the pump is varied, without altering the speed of the



driving motor, by changing the phase of the plungers, so that a proportion of the water passes from one pump barrel to the other without being discharged. The change of phase is effected by rotating the guides in which the cams A A work, relatively to one another.—*November 7th*, 1921.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. PERCY FROST-SMITH asks us to state that he has given up his house at 118, Tonbridge-road, Maidstone, Kent, and that he has opened offices at 64, Victoria-street, Westminster, S.W. 1. Telephone number, Victoria 56.

W. H. ALLEN, SONS AND CO., Limited, Queen's Engineering Works, Bedford, inform us that they have appointed Mr. Harry Astbury, A.M.I. Mech. E., of Empire House, 158, Great Charles-street, Birmingham, as their representative for the Birmingham district.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. 1. "Notes on Searchlight Construction and Operation," by Mr. A. J. Simpson. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. "Conveying and Elevating Machinery," by Mr. Gardiner Mitchell; "Discharge of Grain Cargoes in the Port of London by Pneumatic Elevators," by Mr. R. E. Knight, 6 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Memorial Hall, Albert-square, Manchester. President's Conversazione. 7 p.m.

INSTITUTE OF TRANSPORT: GRADUATES AND STUDENTS.—The Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Operation of a Road Distributing Agency," by Mr. J. Paterson. 5 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS (SCOTTISH CENTRE).—Royal Technical College, Glasgow. "Steel for Locomotive Purposes," by Sir Henry Fowler. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Lecture Theatre, Literary and Philosophical Society, Newcastle-on-Tyne. "Railway Electrification," by Sir Vincent L. Raven, K.B.E. 6.30 p.m.

ELECTRO-HARMONIC SOCIETY.—Great Hall, Cannon-street Hotel. Smoking concert. 8 p.m.

SATURDAY, DECEMBER 17TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the London Graduates to the works of G. N., Limited, East-hill, Wandsworth, S.W. Meet outside the works at 2.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Caxton Hall, S.W. 1. "Management Difficulties," by Mr. F. Turner. 7.30 p.m.

MONDAY, DECEMBER 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Scottish Centre, at the Royal Technical College, Glasgow. Paper, "Tubes," by Mr. W. W. Hackett. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, S.W. 1. Graduates' Meeting. Paper: "Worm Gearing," by Mr. Cyril Poole. 7 p.m.

TUESDAY, DECEMBER 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Ordinary general meeting of the Institution, at the Broadgate Café, Broadgate, Coventry. Paper, "Motor Car Gear Boxes," by Mr. H. F. L. Orcutt. 7.45 p.m.

THE INSTITUTE OF MARINE ENGINEERS.—The Minories, Tower-hill, E. 1. "Notes on Gas Engines." 6.30 p.m.

WEDNESDAY, DECEMBER 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Meeting of the Birmingham Graduates, at the Chamber of Commerce, New-street, Birmingham, when a debate will be held on "Motor Cycle and Sidecar *v.* the Small Car." Graduates of other branches and visitors are invited. 7.30 p.m.

THURSDAY, DECEMBER 29TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, London, W. 1. Children's lectures: "Electric Waves and Wireless Telephony." Lecture I., "Surface Waves on Water and Liquids." 3 p.m.

FRIDAY, JANUARY 6TH, 1922.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Joint meeting with the Society of Chemical Industry. "The Co-operation of the Engineer and Chemist in the Control of Plants and Processes," by Mr. G. M. Gill. 6 p.m.

SATURDAY, JANUARY 7TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS (SCOTTISH CENTRE).—Ball Room, Grosvenor Restaurant, Glasgow. Smoking concert. 6.30 p.m.

LAUNCHES AND TRIAL TRIPS.

EL GRILLO; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of Lobitos Oilfields, Limited; dimensions, 440ft. by 57ft. 2in. by 33ft. 11in.; to carry 10,175 tons on summer draught of 26ft. 3in. Engines, direct-acting surface-condensing triple-expansion marine type, 29in., 48in. and 81in. by 54in. stroke, pressure 180 lb.; constructed by the builders; launch, November 2nd.

JOHN W. MACKAY, telegraph cable repairing steamer; built by Swan, Hunter and Wigham Richardson, to the order of Commercial Cable Company, of New York; dimensions, 360ft. by 48ft. by 35ft. Engines, twin-screw triple-expansion, supplied with steam by three boilers; Howden's forced draught fitted; constructed by the builders; cable will be carried in four cable tanks placed forward of the machinery, which have altogether a coiling capacity of over 50,000 cubic feet; launch, Wednesday, November 30th.

LOSADA, twin-screw cargo motor vessel; built by Harland and Wolff, Limited, to the order of the Pacific Steam Navigation Company; dimensions, 420ft. by 54ft. by 35ft. 3in.; gross tonnage, 6520. Engines, two six-cylinder four-cycle Diesel oil engines, developing a normal output of 3200 indicated horse-power at 115 revolutions per minute; constructed by the builders; trial trip recently.

ABA, passenger motor ship; reconditioned by Harland and Wolff, to the order of British and African Steam Navigation Company, Limited; dimensions, 450ft. by 55ft. 6in. by 33ft.; 8000 gross tonnage. Engines, eight-cylinder four-cycle Diesel oil engines, designed to develop 6600 indicated horse-power; constructed by the builders; left Belfast on November 3rd.

BELLASCO, single-screw cargo steamer; built by John I. Thornycroft and Co., Limited, Woolston, Southampton, to the order of the Dover Shipping Company, Limited; dimensions, length 300ft. between perpendiculars, breadth moulded 43ft. 6in., depth moulded to upper deck 24ft. 5½in.; to carry, 4265 tons deadweight. Engines, triple-expansion, 21in., 34in. and 57in. by 57in. stroke, to develop 1350 indicated horse-power, pressure 180 lb.; constructed by the builders; furnaces arranged for burning coal or oil.

SLIEVE DONARD; passenger steamer; built by Vickers Limited, to the order of London and North-Western Railway Company's Irish Service; dimensions, 310ft. 10in. by 39ft. by 15ft.; to carry 350 tons deadweight; gross tonnage, 1116. Engines, two sets of four-crank triple-expansion, 19in., 29½in. and 33in. by 30in. stroke, pressure 180 lb.; constructed by the builders; trial trip recently.